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VITA

Vaughn Marlan Rundquist was born May 2, 1944, in Hallock, Minnesota, to Mr. and Mrs. Bernard Rundquist. He graduated from Lancaster High School, Lancaster, Minnesota, in May 1962. In September 1962 he enrolled at Moorhead State College, Moorhead, Minnesota, where he received a Bachelor of Arts degree in Biology in June 1966. He began graduate study at the University of Wisconsin, Madison, in June 1966, and completed the work for a Master of Science degree in Wildlife Ecology in July 1969. He began studies for the Doctor of Philosophy degree in Fish and Wildlife Management at Montana State University, Bozeman, in September 1969. He was united in marriage with Lorenne Cookingham at Malta, Montana, on August 11, 1973.

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ABSTRACT

The avian ecology on natural and artificial impoundments in two vegetational types, grassland and sagebrush-grassland, in north-central Montana was studied from 1970 to 1972. Pond dimensions, water-level fluctuations, and selected characteristics of pond water were measured. Upland vegetation was described by a canopy-coverage method. Bird censuses were conducted during about 800 pond visits. The water level of all ponds declined during the summer, with a computed weekly rainfall of 1.35 inches being required for water-level stability. Due to a greater percent of bare soil and a more abrupt contour in the sagebrush-grassland type, ponds had a greater degree of turbidity, accompanied by less plankton and submergents than in the other type. Most of the 113 bird species observed were more numerous in the grassland type. Breeding waterfowl in this type numbered 45.5 pairs per square mile and used temporary waters in the form of natural potholes and reservoir floodplains in addition to permanent waters. Considering all types of ponds, waterfowl in grassland numbered 1.81 breeding pairs per water-surface acre. Mallards *(Anas platyrhynchos)*, pintails *(A. acuta)*, American widgeon *(Mareca americana)*, and blue-winged teal *(A. discors)* formed 74.9 percent of the waterfowl breeding population in grassland. No temporary waters were present in the sagebrush-grassland type, where waterfowl breeding pairs numbered 19.6 per square mile and 2.84 per water-surface acre. Mallards and American widgeon comprised 50.8 percent of the breeding population in sagebrush-grassland. A low density of duck nests was associated with a 67-percent nest success, indicating that primarily nest spacing rather than vegetational cover provided security for nests. An 87-percent seasonal decrease in the water acreage of the grassland type was accompanied by a waterfowl reproductive success one-third as great as in the sagebrush-grassland type, where the seasonal water-acreage decrease was only 8 percent. Grassland had 9.8 broods per square mile, while the other type had 11.1 broods per square mile. Broods numbered 2.95 and 1.86 per water-surface acre in grassland and sagebrush-grassland, respectively. The low reproductive success in grassland may have been related to lowered water levels causing egress of breeding pairs, gonadal inhibition, or strife due to crowding. Fencing ponds was not recommended due to the initial cost involved and the maintenance required to achieve the intended effects.

INTRODUCTION

Wildlife management and agricultural practices constantly interact, producing both adverse effects and mutual benefits. A practice having adverse effects on waterfowl and some other wildlife species has been the drainage of wetlands in the Prairie Pothole Region (Burwell and Sugden 1964; Smith, Stoudt, and Gollop 1964; and Studholme and Sterling 1964). The effects of drainage have been partly offset through the construction of small impoundments. The impoundments were originally designed to supply drinking water for livestock in the arid West and to secure better distribution of grazing pressure. However, the added bonus of waterfowl production was soon apparent (Bue, Uhlig, and Smith 1964 and Edminster 1964). In eastern Montana alone, nearly 8,000 rangeland impoundments had been developed by the Bureau of Land Management before 1970, with a present annual construction rate of approximately 240 impoundments. Private and state agencies also construct many impoundments in this area (Jones 1970). Several workers have studied the value of small impoundments to waterfowl (Bue, Blankenship, and Marshall 1952; Smith 1953; Berg 1956; Shearer 1960; Keith 1961; and Gjersing 1971). Most of these studies were wholly or partly concerned with the relationship between grazing practices and waterfowl production.

The present study was designed to compare two vegetational types, grassland and sagebrush-grassland, with respect to the ecology of bird

populations using the impoundments in each type. The study units in the two vegetational types were similar in all major aspects except vegetation. Field work was conducted from June 8 to September 25, 1970; from April 1 to September 20, 1971; and from March 21 to October 7, 1972.

DESCRIPTION OF THE STUDY UNITS

Both study units were located in southern Phillips County of north-central Montana (Figure 1). Phillips County has been described as a rolling plain dissected by rather deeply entrenched streams and coulees. Most of the stream borders and the more feebly glaciated areas are the sites of rough, broken land, often approaching a badland situation (Gieseker 1926).

The grassland unit was situated about 7.5 miles directly north of the sagebrush-grassland unit. Considering home-range size of waterfowl (Sowls 1955), the separation between study units tended to eliminate any interchange of locally breeding birds. On the other hand, the proximity of the two units provided similar weather conditions. The north and south units covered 8.5 and 8.0 contiguous square miles, respectively.

The grassland unit varied from 2570 to 2870 ft in elevation; the sagebrush-grassland unit varied from 2520 to 2760 ft. The contour of the former unit was somewhat less abrupt than that of the latter. The grassland unit was drained by Beaver and Second Creeks, which empty into the Milk and Missouri Rivers, respectively. The sagebrush-grassland unit was drained by Fourchette Creek, a tributary of the Missouri River. Five soil types occurred in the study units: Phillips loams, Pierre clay loams, Scobey loam, Scobey sandy loam, and Scobey stony loam (Gieseker 1926) (Appendix Figure 18). Four of the types occurred in the grassland unit, and two were found in the other unit.

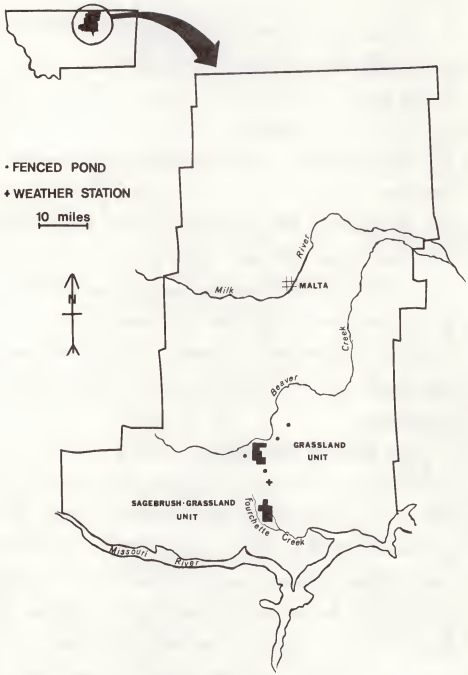

Figure 1. Location of the study units in southern Phillips County, Montana.

Annual temperatures on the study units averaged 41.9 F from 1970 to 1972. The frost-free period extended from mid-May to mid-September. Annual precipitation averaged 12.47 inches from 1960 to 1972. The study units received 3.29 and 1.95 inches above the average in 1970 and 1972, respectively, and 2.41 inches below the average in 1971. Over half of the precipitation falls in the period April through July. Winter snowfall is light. Strong westerlies are common to the area, with chinooks occurring occasionally during the winter (Gieseker 1926 and U. S. Department of Commerce 1960-1972).

The study included 31 unfenced ponds in the grassland unit, 17 unfenced ponds in the sagebrush-grassland unit, and 4 fenced ponds outside the units. The ponds were of three types: natural pothole, dugout, and retention reservoir (Appendix Table 11 and Figures 2 and 3). The natural potholes resembled the temporary and seasonal ponds described by Stewart and Kantrud (1971), while most of the artificial impoundments (dugouts and retention reservoirs) were much more permanent. In the grassland unit, natural potholes and artificial impoundments averaged 1.5 and 2.1 per square mile, respectively, for a total of 3.6 ponds per square mile. The other unit had only retention reservoirs, with an average of 2.1 per square mile. Half of the artificial impoundments in the grassland type had a floodplain in the upper end varying from 2.1 to 16.6 acres and averaging 7.8 acres (Figure 4). The floodplains were vegetated predominantly by spike-edge *(Eleocharis macrostachya)*

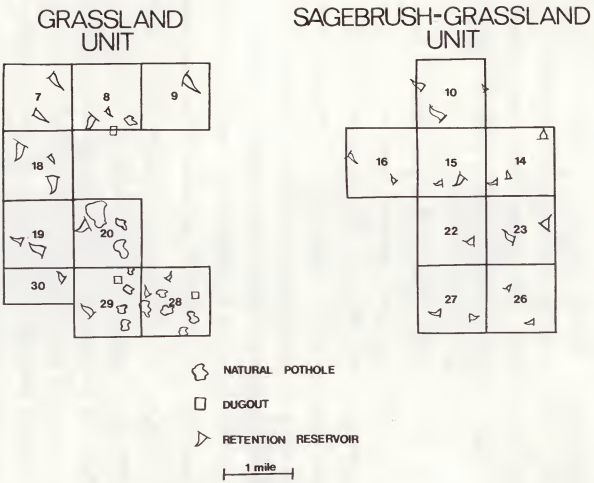

Figure 2. Types and locations of study ponds.

(Appendix Figure 19). None of the retention reservoirs in the sagebrush-grassland type had floodplains. Floodplains apparently resulted from the more gentle topography in the grassland type which allowed impounded water to accumulate at the upper end of the pond basin.

Prominent upland floral components of the grassland study unit were bluestem *(Agropyron smithii)*, blue grama *(Bouteloua gracilis)*, Junegrass *(Koeleria cristata)*, Sandberg bluegrass *(Poa secunda)*, needle-and-thread *(Stipa comata)*, yarrow *(Achillea millefolium)*, fringed sagewort *(Artemisia frigida)*, needleleaf sedge *(Carex eleocharis)*, scarlet globemallow *(Sphaeralcea coccinea)*, lichens, and clubmoss *(Selaginella densa)*. In the sagebrush-grassland unit, the main upland components were the five grass species of the other unit in addition to big sagebrush *(Artemisia tridentata)*, fringed sagewort, needleleaf sedge, broom snakeweed *(Gutierrezia sarothrae)*, plains prickly-pear *(Opuntia polyacantha)*, lichens, and clubmoss. Vegetal cover was much less continuous in this unit than in the grassland unit, and patches of bare ground were common (Figure 5). The main shoreline species in each study unit was spike-sedge. Submergents most often found in each unit were western waterweed *(Elodea occidentalis)*, filamentous green algae, and American milfoil *(Myriophyllum exalbescens)*.

In addition to the avifauna, vertebrates seen on the study units include leopard frog *(Rana pipiens)*, plains garter snake *(Thamnophis radix)*, bull snake *(Pituophis catenifer)*, prairie rattlesnake *(Crotalus*

Figure 5. Patches of bare ground in the sagebrush-grassland unit.

viridis), painted turtle *(Chrysemys picta)*, blacktail prairie dog *(Cynomys ludovicianus)*, muskrat *(Ondatra zibethica)*, beaver *(Castor canadensis)*, mountain cottontail *(Sylvilagus nuttalli)*, whitetail jackrabbit *(Lepus townsendi)*, striped skunk *(Mephitis mephitis)*, badger *(Taxidea taxus)*, red fox *(Vulpes fulva)*, coyote *(Canis latrans)*, pronghorn *(Antilocapra americana)*, and whitetail deer *(Odocoileus virginianus)*.

METHODS

Physical Factors

The initial choice of study units was aided by Bureau of Land Management area maps and by aerial inspection. Final selection of the study units was made following a study of aerial photographs and a reconnaissance from the ground. Hand-drawn maps including useful landmarks were then prepared. Four fenced ponds outside the main study units, two in grassland and two in sagebrush-grassland, were also chosen for study.

Depths of shallow ponds were determined by wading with a sounding pole. Deep ponds were sounded from a boat with a pole or line. In 1972, fluctuating water levels were studied by using a series of 20 metal or wooden stakes. A stake was placed in each fenced pond and in selected unfenced ponds of each study unit. The initial water level was marked on the stake, and the change in level was noted weekly over a period of 3 months beginning in early July. In addition, a visual estimate of water level was made on an irregular basis when ponds were visited during bird censuses. Dates were recorded on which ponds became dry. Pond perimeters were measured in 1971 and 1972 at low water level, and in 1972 at high water level. Perimeter measurements were made with a "tally whacker" used in conjunction with a bicycle wheel pushed along the edge of the water. Pond areas were determined by the weight method (Welch 1948), using paper models prepared from aerial

photographs. Pond-water samples were collected for determining pH, turbidity, water color, and gross nature of suspended and settled matter. Turbidity and pH were measured with a Model DR-EL Hach colorimeter. Turbidity was measured following major rainfalls and during a relatively rainless period and was noted visually during periodic pond visits. Types of pond construction were determined by examination. Construction dates were obtained from Bureau of Land Management records and from interviews with landowners.

Precipitation and air-temperature data recorded at Malta 35S, a weather station located approximately midway between the two study units, were obtained from U. S. Department of Commerce (1960-1972). Personal records were also kept of daily temperature extremes, amounts and types of precipitation, extent of cloud cover, wind direction, and wind velocity.

Vegetative Study

Upland vegetation was analyzed by a canopy-coverage method (Daubenmire 1959a). For analytical purposes, the vegetation of each study unit was sufficiently homogeneous to be considered a single stand. Five 20x50-cm plots equally spaced along each of eight 100-m transects were deemed adequate for characterizing the upland vegetation of each study unit. The percent canopy coverage of each plant taxon; the percent coverages of bare ground, rock, and litter; and the maximum height of herbaceous and shrubby vegetation were recorded for each plot. All plant taxa not encountered in the plots but occurring in a strip 1 m wide adjacent to the transect were listed. Similar procedures were followed for measuring the upland vegetation on each side of the fence at one fenced pond.

Lowland vegetation was described by assigning one of five values (from 0 for none to 4 for fully covered) to the quantity of woody, emergent, and submergent vegetation.

In July 1972, low-altitude infrared aerial photographs were taken of a sample of the ponds in the grassland study unit by Dr. M. P. Meyer, University of Minnesota. The photographs were compared with pond cover maps made by a ground examination.

Daily phenological records were kept of most rangeland forbs from the date of first blossom through the period of anthesis.

Extent of cattle use of ponds and uplands was determined through

Bureau of Land Management records, interviews with ranchers, and periodic counts and estimates. Degree of shoreline trampling by cattle was recorded by using a five-point scale from "no trampling" to "very heavily trampled."

Plant names were taken from Booth (1950) and Booth and Wright (1959).

Bird Observations

Beginning in late June 1970, early April 1971, and late March 1972, bird censuses were conducted during a total of some 800 pond visits. Ten of the 13 natural potholes and one of the dugouts were not visited in 1970, but all ponds in Appendix Table 11 were visited in 1971 and 1972. Each pond was approached by vehicle because, in most cases, observing from the vehicle caused the least disturbance of birds. After one or two visits, the vantage point most suitable in terms of topography, shoreline configuration, and incidence of light was selected and used during most subsequent visits. Observations were made with a 7x35 binocular and a 15-60x variable-power telescope. Each pond was observed for an average of 29 min between early morning and early evening, with 79 percent of the observations beginning before noon. On the average, each pond was visited every 17.7 days in March, April, and May. Visits during the months June through September were made every 24.3 days.

Breeding pairs of waterfowl were censused by counting all pairs, males, and females. For surface-feeding ducks and redheads *(Aythya americana)*, the sum of pairs plus lone males was used for breeding-pair totals. Females were added into the totals only when it was apparent that they were not represented by a male. Pair totals for lesser scaup *(A. affinis)*, canvasbacks *(A. valisineria)*, and ruddy ducks *(Oxyura jamaicensis)* were obtained by adding pairs and females. The breeding population of Canada geese *(Branta canadensis)* consisted of all pairs plus females observed on nests (Hammond 1959). Besides the species, sex, and number of waterfowl, their activity and location of activity on the pond were recorded for both residents (species breeding on the study units) and migrants (species potentially breeding elsewhere). As waterfowl broods appeared, the species, age, brood size, activity, and location of activity were recorded. Brood production was computed by the method of Gollop and Marshall (1954).

During waterfowl censuses, all other birds present were censused by the same methods, with records made of the species, number, and sometimes the sex and relative age.

The species, location, clutch size, characteristics of surrounding vegetation, and fate of bird nests found incidentally were recorded. In June 1971, an organized search for waterfowl nests was conducted with the cooperation of biologists from Northern Prairie Wildlife Research

Center, Jamestown, North Dakota. Some 1,225 acres in grassland and sagebrush-grassland were searched with a cable-chain device (Higgins, Kirsch, and Ball 1969). For each nest found, the stage of incubation was determined with a field candler (Weller 1956) and other information was recorded as for nests found incidentally.

A daily record besides the censuses was kept of all bird species seen on the study units and environs. Bird names were taken from the American Ornithologists' Union (1957).

RESULTS

Water-Level Fluctuations

In 1972 the natural potholes had a maximum of water in early spring, and then decreased gradually. Spring and early-summer rains did not seem to accumulate in the potholes. These observations are supported by the conclusions of Eisenlohr and Sloan (1968) and Eisenlohr (1969), who found that runoff became a source of water for potholes in North Dakota only when the ground was either frozen or saturated. They found that a snow cover of any depth was effective in supplying potholes with water if it melted rapidly while the ground remained frozen, and rain became an important source of water in either a dry or a wet year if a large amount fell within a short period of time.

Retention reservoirs, particularly in the grassland unit, had a relatively low water level early in the spring of 1972, and many of them filled considerably with spring and early-summer rains. Other reservoirs seemed little affected by rainfall. There was thus some doubt concerning the best time to measure pond depths and shoreline lengths. The tendency was to measure ponds after the effects of spring and summer rains had been felt. Consequently many natural potholes were already dry by the time pond measurements were begun.

In general, natural potholes and the extensive floodplains of at least some of the artificial impoundments were dry by early July. In mid-July 1972, a 28-acre pothole was dry enough to permit its cover,

predominantly spike-sedge, to be cut for hay. The seasonal loss of water from natural potholes and floodplains amounted to 87 percent of the water-surface acreage of the grassland unit, decreasing from 25.3 to 3.3 acres per square mile. The water acreage of the other unit decreased only 8 percent, from 6.5 to 6.0 acres per square mile. The more shallow reservoirs and dugouts with maximum water-surface area of less than an acre were generally dry by September. In mid-June 1972 it was noted that the creek in Section 14 of the sagebrush-grassland unit had been reduced to a series of intermittent pools.

The main factors causing fluctuations in pond water level were precipitation, and evaporation as a function of air temperature, relative humidity, wind, water-surface area, and pond depth. Cattle use and seepage were not measured but were thought to be insignificant in contributing to water-level changes.

The water level of all ponds declined during summer 1972 (Figure 6). It was calculated that a weekly rainfall of 1.35 inches during the period of water-level measurement would have been required for the level to remain stable (Figure 7). Ninety percent of the ponds increased or remained the same in level during at least 1 week due to rains. Whether rain caused a particular pond to increase or remain stable for a given week seemed to be determined by the characteristics of the pond watershed as well as by the degree to which the ground was saturated.

The direction and extent of the average weekly fluctuation in

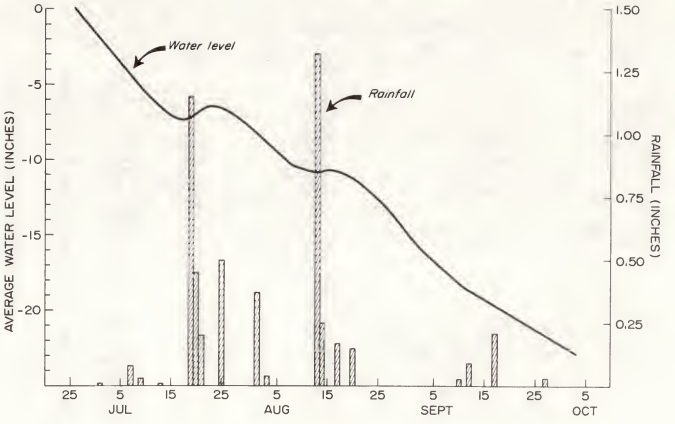

Figure 6. The effect of rainfall on the seasonal decrease of pond water level in 1972.

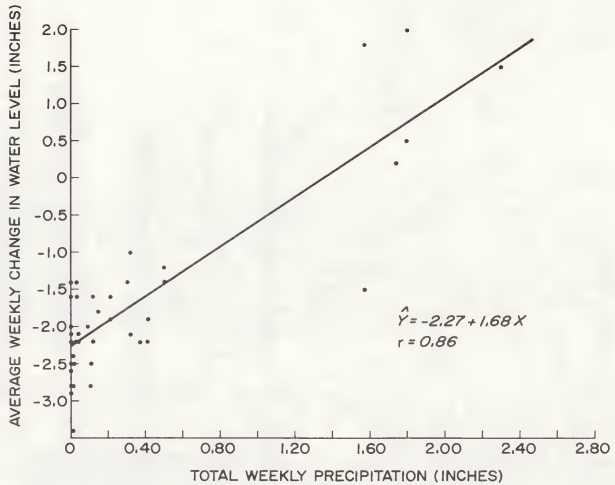

Figure 7. The linear regression of pond water-level fluctuation on precipitation for summer 1972.

water level were closely associated with total weekly precipitation; the linear correlation coefficient was 0.86. The coefficient between average weekly air temperature and water-level fluctuation was insignificantly small.

The linear correlation coefficient between pond depth and the average weekly water-level change was 0.22. The association between water-surface area and weekly change followed a logarithmic function (Figure 8) with a correlation coefficient of 0.77.

Water Quality

The water of 95 percent of the grassland reservoirs and dugouts was judged "clear" during most visits to these ponds in 1970. On the other hand, only 26 percent of the retention reservoirs in the sagebrush-grassland type were considered clear, with the others having various degrees of turbidity.

The water color of ponds in the grassland type ranged from colorless to greenish yellow, and phytoplankton, zooplankton, or detritus occurred in 52 percent of the water samples from this type. Organic matter was present in 29 percent of the sagebrush-grassland samples. No inorganic matter was seen in the grassland samples, but 71 percent of those from the other type contained visible inorganic material. The color of samples from sagebrush-grassland varied from colorless to very chalky.

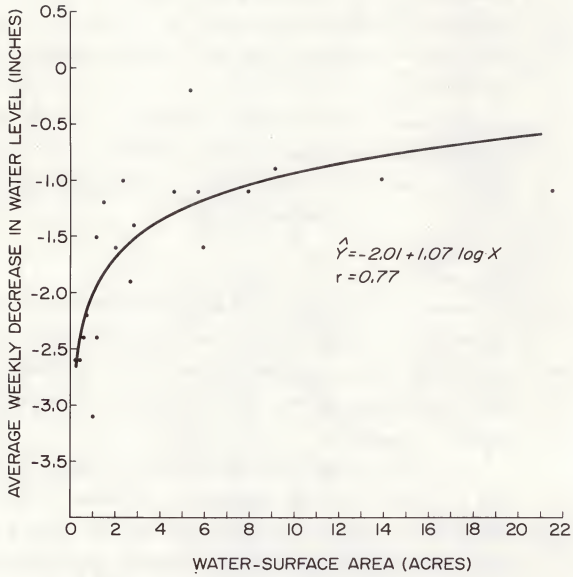

Figure 8. Weekly water loss in relation to water-surface area of study ponds from June 27 to October 3, 1972.

The turbidity measurements in each type in 1972 were used to prepare an analysis of variance for a two-factor factorial (Table 1), with each factor (vegetational type and rainfall intensity) having two levels and unequal subclass samples (Steel and Torrie 1960).

TABLE 1. ANALYSIS OF VARIANCE OF POND-WATER TURBIDITY MEASUREMENTS.

Source of variation	Degrees of freedom	Sum of squares	Mean square
Treatments			
Vegetational type (V)	1	84,554	84,554
Rainfall intensity (R)	1	4,702	4,702
VxR	1	20,186	20,186
Experimental error	37	700,936	18,944
Total	40	810,378	

Using the experimental-error mean square, treatment means were compared by the least significant difference (or LSD) method (Ostle 1963) (Table 2). It was found that there was a difference between the two vegetational types in the effect of both low and high rainfall at the 90 and 95 percent levels of confidence, respectively. Different intensities of rainfall had no significant effect on the degree of pond-water turbidity in grassland, while in sagebrush-grassland there was

TABLE 2. MEASUREMENTS OF POND-WATER TURBIDITY FOLLOWING PERIODS OF LOW AND HIGH RAINFALL.

Vegetational type and relative intensity of rainfall	Turbidity (ppm)		
	Sample Size	Range	Mean[1]
Grassland (G)			
Low rainfall (L)	14	8-104	39.2
High rainfall (H)	8	10-110	38.1
Sagebrush-grassland (S)			
Low rainfall (L)	14	5-410	108.2
High rainfall (H)	5	14-610	190.4

[1]Comparison of treatment means by the least significant difference (or LSD) method (Ostle 1963) gives the following results, where n indicates no significant difference, s indicates a significant difference, and the decimals indicate the level of significance:

	GL	GH	SL	SH
GL	--	n, 0.01	s, 0.10	--
GH		--	--	s, 0.05
SL			--	s, 0.15
SH				--

a difference at the 85 percent confidence level. The differences between the two types were presumably due to a greater percent of bare soil subject to water erosion in the sagebrush-grassland (Appendix Table 12 and Figure 9), in conjunction with a more abrupt contour.

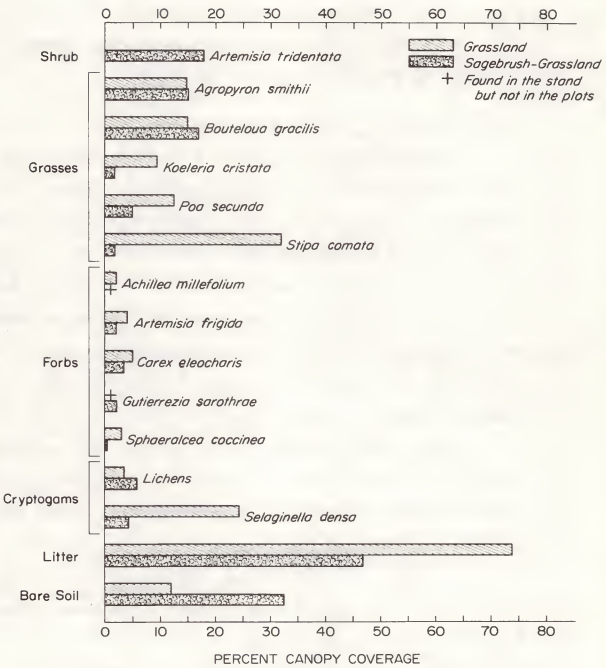

Figure 9. Canopy coverages of the dominant plants in the two vegetational types.

The pH of ponds measured in early October 1972 varied from 8.6 to 9.5 and from 8.3 to 9.8 in grassland and sagebrush-grassland, respectively. The average pH in each type was 9.1.

Upland Vegetation

The sagebrush-grassland type had the general appearance of a shrub community (Figure 10), with big sagebrush providing the most cover (Figure 9). Upland shrubs were almost entirely lacking in the grassland type, where the dominant seed-bearing plants were grasses (Figure 11). The same five species of grass contributed the most grass coverage in each type. The average canopy coverage of the five was 16.7 percent in the grassland unit, which was more than twice that in the other unit (8.1 percent). The most common grasses were needle-and-thread in grassland and blue grama in sagebrush-grassland (Appendix Table 12).

Although a great array of forbs occurred in each type (Appendix Table 13), they were minor in providing cover. Scarlet globemallow and spindle plantain *(Plantago spinulosa)* were the most common forbs in grassland and sagebrush-grassland, respectively, but needleleaf sedge, a grass-like forb, provided the most forb coverage in each vegetational type. It had a coverage of 4.9 percent in the grassland unit and 3.4 percent in sagebrush-grassland.

Clubmoss was an important contributor to grassland cover. Unlike the grasses and forbs, its mat-like growth form closely covered the soil

Figure 10. Aspect of the sagebrush-grassland unit; the dominant plant is big sagebrush.

Figure 11. General appearance of the grassland unit.

surface. As a result of its canopy coverage and growth form, the amount of bare soil in grassland was only about one-third that in the other type. In addition to protecting the soil, clubmoss composed a very high proportion of the litter in the grassland unit. Lichens occurred more frequently than clubmoss in each unit and were found with nearly equal frequency in the two units.

Herbaceous vegetation in the grassland plots ranged from 5 to 29 inches tall, with a mean height of 13.5 inches. That in the sagebrush-grassland plots varied from 4 to 16 and averaged 9.2 inches. Height of big sagebrush within the plots ranged from 1 to 18 and averaged 8.3.

The grassland type was more diverse floristically. Sixty-one plant taxa were identified along the transects, compared with 53 taxa along sagebrush-grassland transects. The number of taxa per grassland plot ranged from 7 to 15 and averaged 10.4; in the other type, the range was 3 to 14 with an average of 7.8. The averages were statistically different at the 99-percent confidence level.

Pond Vegetation

Two species of trees (plains cottonwood [*Populus deltoides occidentalis*] and peachleaf willow [*Salix amygdaloides*]) and five of shrubs were found at ponds in the two vegetational types (Table 3). In the sagebrush-grassland type, trees and shrubs were much more prominent in terms of plant maturity, quantity of woody growth, and percent of

TABLE 3. THE OCCURRENCE OF WOODY PLANTS ON RETENTION RESERVOIRS AND NATURAL POTHOLES.

Woody plant		Retention reservoirs				Natural potholes	
		G[1]		S[2]			
Latin name	Common name	No.	%	No.	%	No.	%
Artemisia tridentata	Big Sagebrush	1	5.9	0	0	0	0
Populus deltoides occidentalis	Plains Cottonwood	2	11.8	6	31.6	0	0
Ribes aureum	Golden Currant	1	5.9	3	15.8	0	0
Rosa woodsii	Woods Rose	4	23.5	11	57.9	3	23.1
Salix amygdaloides	Peachleaf Willow	5	29.4	8	42.1	0	0
Salix exigua	Slender Willow	3	17.6	13	68.5	0	0
Symphoricarpos occidentalis	Western Snowberry	0	0	2	10.5	0	0
Total having woody plants		9	52.9	14	73.7	3	23.1

[1] Grassland vegetational type.
[2] Sagebrush-grassland vegetational type.

ponds having woody species. Six species occurred in each type. In the grassland type, individual ponds had three species or less, while each pond in the other type had as many as six species. The age of a pond apparently did not determine the diversity of species present. They occurred at retention reservoirs and natural potholes, but none of the dugouts had woody vegetation. In general, the dams supported the most and oldest woody plants at reservoirs.

There seemed to be no relationship between pond age and presence of woody vegetation. A 5-year-old pond had a few young plants of slender willow *(S. exigua)* and plains cottonwood. At another pond of the same age were found slender willow and plains cottonwood in addition to a small amount of Woods rose *(Rosa woodsii)* and young peachleaf willow. Other ponds up to at least 25 years old had no woody vegetation.

Pond permanence seemingly did not determine the amount of woody growth present. Some of the permanent ponds lacked woody cover, while a small pond that tended to become dry each year supported a heavy growth of four woody species, one of which was of considerable age.

Important herbaceous plants in the ecotone between upland and shoreline cover in both vegetational types were foxtail barley *(Hordeum jubatum)* and bluestem (Appendix Figures 20, 21, and 22). Spike-sedge and needle spike-sedge *(Eleocharis acicularis)* were the dominant emergents of pond shorelines in each type. The basins of natural potholes were covered predominantly by the former species (Appendix Figure 23).

Five (26 percent) of the sagebrush-grassland ponds had heavy shoreline stands of common cattail *(Typha latifolia)*, a species not found at grassland ponds. The quantity of emergents seemed to vary directly with the amount of cattle use of ponds and the extent of floodplain adjoining pond basins.

In both types, the dominant submergent species was American milfoil, followed by filamentous green algae and western waterweed. In addition, pondweed *(Potamogeton richardsonii)* was relatively prominent in ponds in the sagebrush-grassland type. On a quantitative scale ranging from 0 to 4, the submergent values for grassland reservoirs varied from 1 to 4 with a mean of 3.4. Reservoirs of the other type had values ranging from 0 to 4 and a mean of 2.5. The lower mean value in sagebrush-grassland may be the result of the intolerance of submergents to higher levels of water turbidity. In both types, quantities of submergents were predominantly 3 and 4 for turbidity readings up to about 100 ppm, and 1 and 0 for higher turbidity readings.

Infrared photographs were useful for indicating the presence of submergents and for distinguishing lowland from upland vegetation. However, they could not be used to identify individual species of plants.

Livestock Grazing

Ownership of the grassland unit was 47.8 percent private and 52.2 percent public; the corresponding statistics for the other unit were

32.8 and 67.2 percent. Each unit was open to grazing except for 160 and 640 acres in grassland and sagebrush-grassland, respectively. Continuous grazing was permitted during the period April 10 to November 30 in the grassland unit, and April 1 to December 15 in the other unit. However, cattle generally were not turned into the pastures until late April when the vegetation became suitable for grazing.

The trampling of shoreline vegetation was an effect of grazing potentially influencing water-bird ecology (Figure 12). The least trampling occurred at natural potholes (Table 4), a tendency reflecting their presence only during a time of greater water abundance, coupled with a decreased demand for livestock drinking water due to more succulent vegetation and lower air temperatures. Dugouts received the most trampling for the small number of observations made in this study. In a study by Gjersing (1971), trampling reduced shoreline vegetation to a height of 3 inches or less within a period of 2 weeks, and recovery of the vegetation required about a year without grazing. On this basis, one would not expect a year-to-year change in the trampling index of the present study under the conditions of continuous grazing. Data on cattle numbers were inadequate to show any clear relationship between the intensity of trampling and the amount of shoreline available per cow, but an inverse relationship is presumed.

When water levels were low in late summer, cattle were able to enter the enclosure at three of the fenced ponds by going around the end

Figure 12. Fenced retention reservoir S3 in the sagebrush-grassland type; trampled shoreline on the right and typical shoreline cover on the left.

TABLE 4. SHORELINE TRAMPLING INDEX COMPARED WITH CATTLE USE OF PONDS, 1971 AND 1972.

Vegetational and pond types	1971						1972					
	Trampling index[1]			No. of cattle observed per pond visit			Trampling index			No. of cattle observed per pond visit		
	n[2]	R[3]	$\bar{X}$[4]	n	R	$\bar{X}$	n	R	$\bar{X}$	n	R	$\bar{X}$
Grassland												
Natural pothole	--	--	--	--	--	--	13	0-2	1.1	25	0-34	6.8
Dugout	1	--	3.0	--	--	--	3	3-4	3.3	5	0-9	1.8
Retention reservoir	12	0-4	2.5	--	--	--	17	0-4	2.5	58	0-175	20.6
Sagebrush-grassland												
Retention reservoir	16	0-4	2.4	142	0-102	6.5	19	0-4	0.9	104	0-75	4.1

1 The trampling index ranges from 0 for no trampling to 4 for very heavy trampling.
2 Sample size.
3 Range.
4 Mean.

of the fence which earlier in the season projected into the water. Cattle also entered via breaks in the fence. The number of cattle involved in these instances ranged from 3 to 34. Consequently trampling occurred on both sides of the fence at these ponds.

The other fenced pond was situated in sagebrush-grassland and had been fenced in 1966. Six years without grazing apparently made no difference in the height of upland herbaceous cover in plots within the fence. It ranged from 1 to 13 inches tall and averaged 6.0 inches, compared with a range of 1 to 14 and an average of 5.9 outside the fence. A single shrub 10 inches tall was encountered along the transect inside, while shrub height outside ranged from 3 to 13 inches with an average of 7.5 for a sample of six.

According to Stoddart and Smith (1955), Daubenmire (1959b), and Odum (1971), grazing tends to change floristic composition from many to fewer species, with the remaining species often increasing in number and size due to decreased competition. These effects were indicated at the fenced pond, where 42 plant taxa were identified along the transect within the fence, while only 30 were identified outside (Appendix Table 14). Canopy coverages of most of the dominant species were greater outside the fence. A change in floristic composition was not apparent from the number of taxa per plot, which ranged from 1 to 11 inside the fence and 2 to 11 outside. The averages per plot were 5.3 and 5.6 for the inside and outside, respectively; they were not

statistically different at the 95-percent confidence level.

Studies of Birds Other Than Waterfowl

Bird species observed on or near the study units numbered 113, of which 11 (9.7 percent) were year-round residents, 16 (14.2 percent) were migrants outside their normal breeding ranges, and 86 (76.1 percent) were migrants within their breeding ranges (Appendix Table 15). Species recorded on or near the ponds numbered 93, eighty-two percent of the total.

The indications of abundance show that most species were more numerous in the grassland type. The abundance statistics may be somewhat biased, since, in traveling to the sagebrush-grassland type, the grassland type was crossed, providing additional opportunities for observation in that type. Nevertheless, on the basis of roadside counts of small birds, production figures of grebes and American coots *(Fulica americana)*, and nest records, it was concluded that the relative abundance statistics corresponded to existing numbers.

The profusion of small upland birds in grassland and their relative lack in the other vegetational type were obvious while traveling the roads in each type. In August 1972, a count of small upland species, mainly horned lark *(Eremophila alpestris)*, western meadowlark *(Sturnella neglecta)*, and chestnut-collared longspur *(Calcarius ornatus)*, was made along 4 miles of improved dirt road in each vegetational type under

similar weather conditions. The counts were 59 birds per mile in grassland, but only four per mile in the other type.

The production of grebes and American coots followed a similar pattern (Table 5). The total production per water-surface acre for the three grebe species was twice as great in the grassland unit. Grebe production per acre on the two grassland fenced ponds was equal to that of unfenced ponds in the grassland unit, but there was no production on sagebrush-grassland fenced ponds. Coot production was likewise greater on grassland ponds, and the production on unfenced ponds in each unit was greater than on the corresponding fenced ponds. No young of grebes or coots were seen on natural potholes. There was no apparent reason for the decrease in grebe and coot production from 1970 to 1972. The decrease did not seem to follow yearly water-level changes.

Bird nests found in grassland numbered 35, while only 10 were found in sagebrush-grassland (Appendix Table 16). Nest success when determined by Kalmbach's (1939) method was similar to that in his report, even with small sample sizes (Table 6).

Waterfowl Studies

Nineteen species of waterfowl were observed in the study. The young of 12 of them were seen on study ponds. An additional species, cinnamon teal *(Anas cyanoptera)*, was also considered a summer resident on the study units, but no young were identified. The remaining six

TABLE 5. GREBE AND AMERICAN COOT PRODUCTION IN EACH VEGETATION TYPE, 1970–1972.

Species and vegetational type	1970		1971		1972		3-yr avg	
	No. young	No. young per acre of water surface	No. young	No. young per acre of water surface	No. young	No. young per acre of water surface	No. young	No. young per acre of water surface
Horned Grebe								
G[1] unit	0	0	0	0	4	0.09	1.3	0.03
S[2] unit	0	0	0	0	0	0	0	0
G fenced ponds	0	0	0	0	2	0.08	0.7	0.03
S fenced ponds	0	0	0	0	0	0	0	0
Eared Grebe								
G unit	1	0.02	3	0.07	0	0	1.3	0.03
S unit	7	0.14	3	0.06	16	0.32	8.7	0.17
G fenced ponds	7	0.30	9	0.38	0	0	5.3	0.23
S fenced ponds	0	0	0	0	0	0	0	0
Pied-Billed Grebe								
G unit	32	0.74	24	0.56	4	0.09	20.0	0.46
S unit	6	0.12	3	0.06	3	0.06	4.0	0.08
G fenced ponds	7	0.30	11	0.47	0	0	6.0	0.26
S fenced ponds	0	0	0	0	0	0	0	0
American Coot								
G unit	174	4.00	81	1.86	12	0.28	89.0	2.05
S unit	53	1.06	0	0	0	0	17.7	0.35
G fenced ponds	46	1.94	38	1.60	0	0	28.0	1.18
S fenced ponds	1	0.07	0	0	0	0	0.3	0.02

[1] Grassland.
[2] Sagebrush-grassland.

Table 6. THE SUCCESS OF FOUR TYPES OF BIRD NESTS.

Nest type	Nest success		
	Grassland	Sagebrush-grassland	Study by Kalmbach (1939)
Upland ground nests	50% (6)[1]	20% (1)	43%
Above-ground nests	67% (2)	100% (1)	52%
Waterfowl nests [2]	62% (13)	100% (4)	60%
Hole nests	100% (1)	--	73%

[1]Sample size.
[2]Including American coot and horned grebe *(Podiceps auritus)* nests.

species were recorded only during migration. Several waterfowl anomalies were also observed: a partially albino male gadwall *(A. strepera)*, a mallard-pintail hybrid, and a blue-winged teal-shoveler *(Spatula clypeata)* hybrid. Both hybrids were mentioned by Cockrum (1952) in his list of hybrid birds, and Kortright (1953) indicated that hybridism is rather common among wild waterfowl.

Waterfowl Breeding Populations

Canada geese, mallards, and pintails were found using the ice-free portions of study ponds when spring field work was begun (Appendix Table 15). Close subsequent arrivals included green-winged teal *(Anas carolinensis)*, redheads, American widgeon, shovelers, lesser scaup, and

gadwalls. Blue-winged teal, canvasbacks, and ruddy ducks were the latest arrivals of waterfowl species breeding on the study units. This arrival sequence was similar to that reported by Ellig (1955) for Greenfields Lake in western Montana, by Sowls (1955) and Hochbaum (1959) for the Delta Marsh in south-central Manitoba, and by Keith (1961) for southeastern Alberta.

The 12 species listed above were represented in the sagebrush-grassland unit, and all except the canvasback were observed as breeding birds in the other unit. Totals for individual species and ponds appeared to be more stable in the sagebrush-grassland unit from 1971 to 1972 (Appendix Table 17). Based on averages for the 2 years, Canada geese and undetermined ducks together composed 3.5 and 4.8 percent of the breeding population in the grassland and sagebrush-grassland units, respectively (Table 7). Excluding these birds, the composition of the remaining ducks was 95.6 and 87.2 percent surface feeders, and 4.4 and 12.8 percent diving species in the two units. These data parallel those at Greenfields Lake, Montana, for eight species of surface-feeding ducks and four of divers in grassland and greasewood *(Sarcobatus vermiculatus)*-grassland, respectively (Ellig 1955).

Mallards, pintails, American widgeon, and blue-winged teal each contributed more than 10 percent of the breeding population in the grassland unit; together they comprised 74.9 percent of the population. Pintails, the largest contributor, made up a third of the breeding

TABLE 7. PERCENT COMPOSITION OF THE WATERFOWL BREEDING POPULATION AND BROOD PRODUCTION IN EACH STUDY UNIT.

Species	Breeding population		Brood production	
	G[1,3]	S[2,3]	G[3]	S[4]
Mallard	14.7	17.9	10.2	9.0
Pintail	32.6	8.3	18.1	2.6
Gadwall	6.6	7.7	6.0	9.8
American Widgeon	14.2	32.9	21.1	42.1
Shoveler	7.9	3.2	8.4	1.1
Blue-Winged Teal	13.4	8.9	21.7	15.4
Green-Winged Teal	2.8	4.2	0	0.4
Lesser Scaup	3.1	7.9	1.2	7.1
Redhead	0.9	0.6	0	0
Canvasback	0	3.2	0	1.5
Ruddy Duck	0.3	0.3	0	0
Canada Goose	3.4	3.5	6.0	1.9
Undetermined Duck	0.1	1.3	7.2	9.0
Total	100.0	99.9	99.9	99.9

[1]Grassland unit.
[2]Sagebrush-grassland unit.
[3]Averages of 1971 and 1972 data.
[4]Averages of 1970 to 1972 data.

waterfowl. Only two species, mallards and American widgeon, composed more than 10 percent of the population each in the sagebrush-grassland unit, and their total was 50.8 percent. Widgeon were numerically dominant in this unit, forming a third of the population.

The grassland unit had more than twice as many waterfowl pairs per square mile as the other unit (Figure 13). This population included pairs using natural potholes, a type of pond in grassland which held water only temporarily early in the breeding season. However, considering only retention reservoirs, the most permanent pond type, grassland still had half again as many pairs per square mile as sagebrush-grassland.

In addition to using natural potholes and retention reservoirs, breeding pairs used the three dugouts, and a few mallard and widgeon pairs were observed incidentally on the creek in the sagebrush-grassland unit. In the grassland unit, waterfowl used retention reservoirs more than twice as much as either natural potholes or dugouts with respect to pairs per water-surface acre (Table 8). Retention reservoirs and natural potholes in the grassland unit were used most heavily by pintails; dugouts were used mostly by blue-winged teal. Retention reservoirs in the other unit had the greatest use by widgeon. Natural potholes were not used by diving ducks, and the only divers using a dugout were a pair of redheads. Surface-feeding ducks used mostly the shallower portions of ponds, while the diving ducks generally favored the deeper parts. The occurrence of a greater population of divers in the

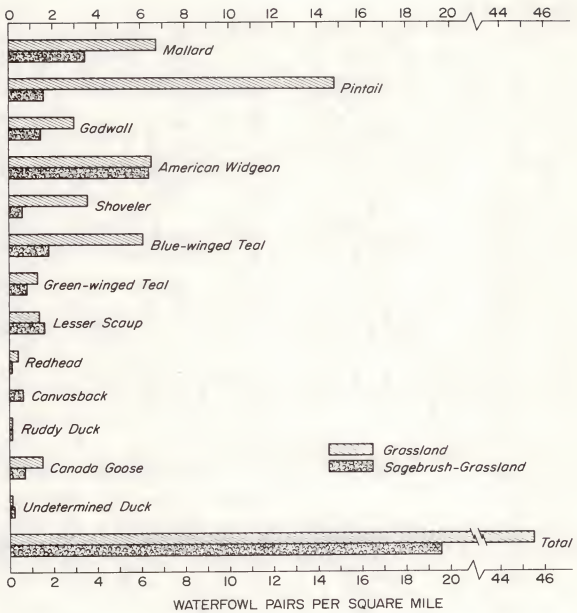

Figure 13. Waterfowl breeding populations in the two study units (averages from 1971 and 1972 breeding-pair censuses). The grassland unit had no canvasback pairs.

TABLE 8. NUMBER OF WATERFOWL BREEDING PAIRS PER ACRE OF WATER SURFACE (AT HIGH WATER LEVEL) IN EACH VEGETATIONAL TYPE (AVERAGES OF 1971 AND 1972 DATA).

	Grassland type						Sagebrush-grassland type	
	Study unit						Study unit	
Species	NP[1]	DO[2]	RR[3]	DO+RR	NP+DO+RR	Fenced RR	RR	Fenced RR
Mallard	0.18	0.18	0.41	0.36	0.27	0.48	0.42	0.31
Pintail	0.51	0.23	0.78	0.68	0.59	0.46	0.25	0.21
Gadwall	0.02	0.08	0.26	0.23	0.12	0.27	0.23	0.17
American Widgeon	0.13	0.13	0.46	0.40	0.26	0.67	0.93	0.52
Shoveler	0.07	0.16	0.24	0.22	0.14	0.10	0.10	0.10
Blue-Winged Teal	0.12	0.34	0.39	0.38	0.24	0.30	0.27	0.10
Green-Winged Teal	0.04	0.08	0.07	0.07	0.05	0.11	0.12	0.03
Lesser Scaup	0	0	0.15	0.12	0.06	0.19	0.24	0.31
Redhead	0	0.03	0.04	0.03	0.02	0.27	0.02	0.17
Canvasback	0	0	0	0	0	0.06	0.10	0
Ruddy Duck	0	0	0.01	0.01	0	0.04	0.01	0
Canada Goose	0.02	0.03	0.13	0.11	0.06	0.08	0.11	0.07
Undetermined Duck	0	0	0	0	0	0	0.04	0
Total	1.09	1.25	2.94	2.61	1.81	3.03	2.84	1.99

1 Natural pothole.
2 Dugout.
3 Retention reservoir.

sagebrush-grassland unit may be explained by the greater average pond depth in that unit.

Grassland retention reservoirs had about the same use per water-surface acre as those in the other unit. The fenced reservoirs in grassland were used about as much as the unfenced ones in that cover type. In sagebrush-grassland, however, the fenced reservoirs were used 70 percent as much as the unfenced ones, and only two-thirds as much as the fenced reservoirs in grassland. The lighter use of sagebrush-grassland fenced ponds was largely due to low numbers of waterfowl at one of the two. This pond was probably unattractive because of an extreme degree of water turbidity and a heavy stand of common cattail.

With respect to length of shoreline on artificial impoundments, the grassland unit had only a little more than half the amount of shoreline per breeding pair that was found in the other unit (Table 9). Widgeon had the least shoreline per pair in each unit.

Waterfowl Nest Study

As determined mainly from brood ages and sizes, the initiation of nesting by the various waterfowl species spanned a period of 2.5 months beginning in April (Figure 14). The nests of seven species of waterfowl were found (Appendix Table 18). Nests discovered incidentally in 1971 and 1972 numbered 16 (10 in grassland and 6 in sagebrush-grassland); an equal number (15 and 1) was found during the 1971 organized nest search. Only about 9 acres of sagebrush-grassland were searched due to

TABLE 9. LENGTH OF SHORELINE PER BREEDING PAIR OF WATERFOWL IN EACH STUDY UNIT IN 1972 (DUGOUTS AND RETENTION RESERVOIRS ONLY).

Species	Length of shoreline (yards)	
	Grassland unit	Sagebrush-grassland unit
Mallard	230	410
Pintail	250	860
Gadwall	530	740
American Widgeon	180	180
Shoveler	570	2,590
Blue-Winged Teal	430	860
Green-Winged Teal	2,290	940
Lesser Scaup	1,140	690
Redhead	6,850	5,180
Canvasback	--	2,070
Ruddy Duck	--	--
Canada Goose	570	2,070
Undetermined Duck	--	10,370
Total	40	70

destruction of big sagebrush by the search method; the balance of the approximately 1,225 acres searched was in grassland.

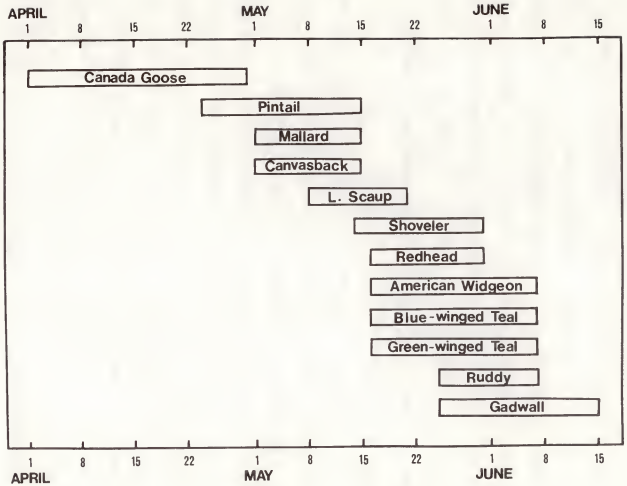

Figure 14. Peaks of initial nesting activity based mainly on data from 1970 to 1972. The peaks were used as breeding-population census periods.

During the nest search, June 8 to 10, the nest density in grassland was about one nest per 100 acres. This statistic would be modified by the addition of nests already terminated as well as those initiated later. There seemed to be no greater concentration of nests in heavier cover. The pintail nests were in typically open sites with little cover surrounding them. The three American widgeon nests found in sagebrush-grassland were beneath big sagebrush plants. The other duck nests were commonly in stands of crested wheatgrass *(Agropyron cristatum)* and prairie thermopsis *(Thermopsis rhombifolia)*. Five (56 percent) of the nine Canada goose nests were situated on a peninsula or on temporary islands formed during high water.

Where the outcome of nests was known, 67 percent of them hatched. This degree of nesting success was considerably greater than that reported for a variety of habitats by Ellig (1955), Sowls (1955), Labisky (1957), Keith (1961), Smith (1971), and Stoudt (1971). Successful nests averaged 337 yards from water, while depredated nests were an average of 244 yards. The average distances of nests from water for individual species were: mallard, 220 yards; pintail, 273; gadwall, 430; American widgeon, 353; shoveler, 347; blue-winged teal, 60; and Canada goose, 9.

Most nest destruction resembled that attributed to the common crow *(Corvus brachyrhynchos)* (Rearden 1951), but very few crows or black-billed magpies *(Pica pica)*, another nest predator (Kalmbach 1939 and Martin, Zim, and Nelson 1951), were observed on or near the study units

(Appendix Table 15). Potential mammalian nest predators observed on the study units were the striped skunk, red fox, and coyote.

Waterfowl Brood Production

The young of 12 waterfowl species were observed on study ponds (Appendix Table 19). Only one brood was positively identified as green-winged teal, and this occurred on a reservoir in the sagebrush-grassland unit. Redhead and ruddy duck broods were seen only on grassland fenced reservoirs. Undetermined broods consisted largely of one or two apparently orphaned ducklings.

In the grassland unit, the composition of the brood production was 85.5 percent surface-feeding ducks, 1.2 percent diving species, and 6.0 percent Canada geese (Table 7). The corresponding percentages for the other unit were 80.4, 8.6, and 1.9. Mallards, pintails, widgeon, and blue-winged teal each comprised at least 10 percent of the brood production in the grassland unit. Together they made up 71.1 percent of the broods. In the other unit, only widgeon and blue-winged teal comprised more than 10 percent of the broods, together amounting to 57.5 percent.

Total brood production per square mile in the grassland unit was somewhat less than in the other unit (Figure 15). Production was greater in grassland than in sagebrush-grassland in the case of five species; four species were more productive in sagebrush-grassland. The greatest

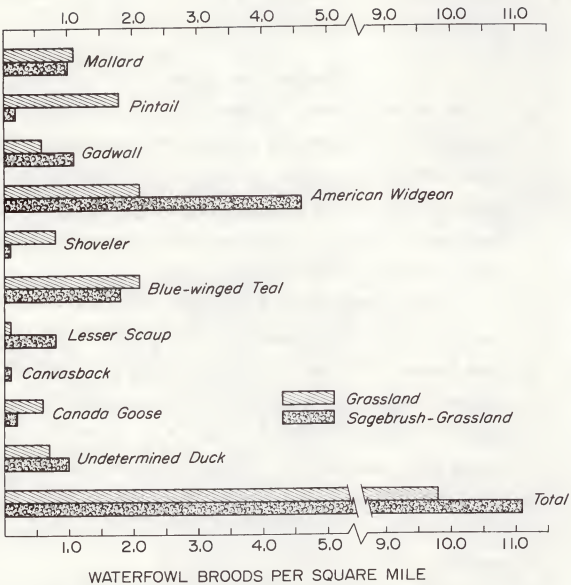

Figure 15. Waterfowl brood production in the two study units (averages from brood censuses for 1971 and 1972 in grassland and for 1970 to 1972 in sagebrush-grassland). Averages for green-winged teal, redheads, and ruddy ducks in both units, and for canvasbacks in the grassland unit were zero.

contributors to the production in the grassland unit were widgeon and blue-winged teal, and each contributed equally. The most productive in the sagebrush-grassland unit was the American widgeon.

Although the grassland unit produced fewer duck broods per square mile, class-III broods (Gollop and Marshall 1954) were larger in that unit (Appendix Table 20), tending to minimize the difference. Thus the number of ducklings reared to flying stage was 47.8 and 49.0 per square mile in the grassland and sagebrush-grassland units, respectively. The apparent increase in brood size from class II to class III has been noted in other reports and has been ascribed to brood aggregation (Miller and Collins 1954, Hochbaum 1959, and Keith 1961).

The only natural potholes having broods were two of the largest ones, which had a total of three pintail broods in 1971 but none the following year (Appendix Table 19).

The broods of Canada geese and five species of surface-feeding ducks were observed on dugouts (Table 10). A sample of only three dugouts and the low surface acreage of each account for the large total of 6.36 broods per acre. The borrow-pit dugout (Appendix Table 11) had just two broods, both in 1972. A dugout constructed in a natural pothole had a yearly average of 5.7 broods from 1970 to 1972. A dugout on level ground had only one brood in the 3 years.

Except for the three dugouts, grassland-unit reservoirs produced the most broods per acre of water surface (Table 10). The production

TABLE 10. NUMBER OF WATERFOWL BROODS PER ACRE OF WATER SURFACE (AT LOW WATER LEVEL) IN EACH VEGETATIONAL TYPE.

Species	Grassland type				Sagebrush-grassland type	
	Study unit			Fenced	Study unit	Fenced
	DO[1,2]	RR[3,4]	DO+RR[2]	RR[2]	RR[4]	RR[4]
Mallard	0.45	0.26	0.31	0.28	0.17	0.14
Pintail	0.91	0.35	0.49	0.16	0.05	0.05
Gadwall	0	0.24	0.18	0.23	0.18	0.19
American Widgeon	0.91	0.53	0.63	0.46	0.78	0.30
Shoveler	0.91	0.40	0.25	0.32	0.02	0.02
Blue-Winged Teal	1.82	0.69	0.65	0.30	0.28	0.02
Green-Winged Teal	0	0	0	0	0.01	0
Lesser Scaup	0	0.05	0.04	0.07	0.13	0.07
Redhead	0	0	0	0.09	0	0
Canvasback	0	0	0	0.05	0.03	0.02
Ruddy Duck	0	0	0	0.02	0	0
Canada Goose	0.91	0.14	0.18	0.09	0.04	0.02
Undetermined Duck	0.45	0.24	0.22	0.28	0.17	0
Total	6.36	2.90	2.95	2.35	1.86	0.83

[1] Dugout.
[2] Averages of 1971 and 1972 data.
[3] Retention reservoir.
[4] Averages of 1970 to 1972 data.

per acre on reservoirs in the other unit was only about two-thirds as great. Fenced and unfenced reservoirs in grassland were nearly equal in production, while fenced reservoirs in the other type were the least productive of all reservoirs. This was again undoubtedly due to the seeming unattractiveness of one of the two fenced ponds in sagebrush-grassland. The data further suggest that the production per acre on the small artificial impoundments studied was relatively constant regardless of pond size.

Brood movements between ponds, as observed by Evans, Hawkins, and Marshall (1952) and Berg (1956), probably occurred often. However, they were noted with some certainty in only two cases. One was a pintail hen with four class-III ducklings which moved from one grassland reservoir to another 0.4 mile away within 24 hr. The other case was a Canada goose pair and six goslings of subclass Ia (Yocom and Harris 1965) which moved 1.2 miles between two grassland reservoirs in 21 hr or less.

All species producing young, except shovelers, had fewer broods per breeding pair in the grassland unit than in sagebrush-grassland (Figure 16). Considering the entire breeding population, the grassland unit produced about one-third as many broods per pair as did the other unit. On retention reservoirs alone there were only about half as many broods per waterfowl pair in the grassland unit as in the sagebrush-grassland unit (Figure 17).

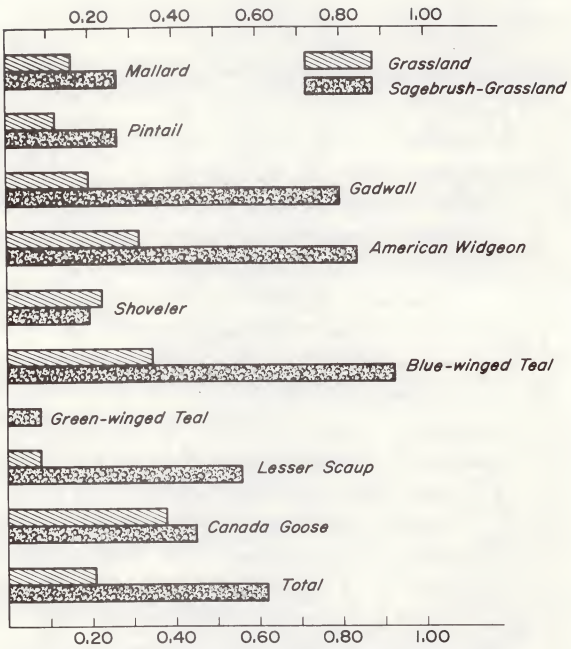

Figure 16. Brood production per pair on all ponds in each study unit, from 1971 and 1972 census averages. There were no redhead, canvasback, or ruddy duck broods in either unit, and the grassland unit had no green-winged teal broods.

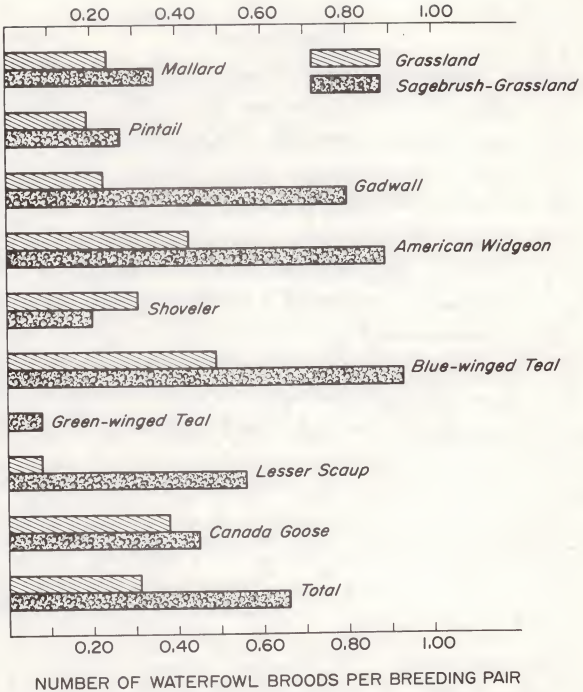

Figure 17. Brood production per pair on retention reservoirs in each study unit, from 1971 and 1972 census averages. There were no redhead, canvasback, or ruddy duck broods in either unit, and the grassland unit had no green-winged teal broods.

Waterfowl Mortality

Dead waterfowl were seldom found, and only two causes of mortality, accidents and predation, were suspected or observed. A widgeon and a pintail, both adult males, were killed apparently by striking power lines. Another adult male pintail was found partly eaten, but the cause of death was not determined. A marsh hawk *(Circus cyaneus)* was observed to prey successfully on what appeared to be an adult blue-winged teal. Predation by other raptors was not noted, although on one occasion some ducks reacted to the presence of a golden eagle *(Aquila chrysaetos)* by swimming en masse from the upper end of a reservoir to the center. Eight dead ducklings ranging in age from subclass Ia to III were found. They included two pintails, a widgeon or blue-winged teal, and five undetermined ducklings. The cause of death was unknown in all cases.

DISCUSSION

The grassland and sagebrush-grassland study units were considerably different in vegetational cover and avian populations. Soil type and topography were both undoubtedly important in determining the difference in vegetational composition between the two units. Topography seemed to be a major factor determining the differences observed in the characteristics of the ponds in the two units. The pond characteristics, in turn, were reflected in the responses of the waterfowl populations.

The more gentle grassland topography made possible the natural potholes and the floodplain at the upper end of reservoirs. Both features were sites of temporary water during the spring and early summer. In contrast, such temporary waters were virtually absent in the sagebrush-grassland unit. By late summer, the grassland unit had suffered a drastic decrease in water-surface acreage, while the ponds in the sagebrush-grassland unit showed only slight drawdowns within the drainage channels themselves.

The difference in water stability between the two units was matched by equally great differences in the responses of their respective waterfowl populations. The grassland unit attracted about as many breeding pairs per water-surface acre of retention reservoir as did the other unit. However, the grassland unit had a greater acreage per square mile in reservoirs, due to the floodplains, and consequently this unit had more pairs per square mile. The grassland unit also had a large acreage

in natural potholes. Even though potholes had fewer pairs per water-surface acre than any other type of pond in either unit, the large water area involved gave further increase to the count of pairs per square mile in the grassland unit. The final result was more than twice as many pairs per square mile in grassland as in sagebrush-grassland.

The basic response to the large seasonal change in water area in the grassland unit seemed to be a decreased reproductive efficiency relative to that in the sagebrush-grassland unit. The number of broods per water-surface acre was greater in the grassland unit. However, this unit had fewer broods per square mile because there was less water acreage per square mile during the brood-rearing period. The seeming discrepancy of more broods than breeding pairs per water-surface acre in the grassland unit is explained by the fact that the percent decrease in water area was greater than the percent of unsuccessful pairs. As expected, with a minimum of water-area shrinkage in the sagebrush-grassland unit, the number of broods per acre was less than the number of pairs per acre.

Rogers (1964) indicated that many resident lesser scaup moved from a breeding area without nesting, and only a few of the remaining resident pairs attempted to nest, both responses apparently resulting from very low water levels. Decreased water levels in the present study may have resulted in one or both of the same two responses by resident breeding waterfowl pairs in the grassland unit. Pairs may have left that unit

for areas such as the sagebrush-grassland having greater water stability. This alone would have accounted for a lowered reproductive rate for the grassland unit, even if all remaining pairs had reproduced at a rate equal to that in the other unit. On the other hand, if there was no egress of breeding pairs from the grassland unit, if they simply moved from the less to the more stable ponds within the unit, the lowered reproductive efficiency may have been a result of gonadal inhibition due to decreased habitat quality or intraspecific and, conceivably, interspecific strife due to crowding.

For avian species other than waterfowl, grassland was apparently more attractive than sagebrush-grassland as evidenced by the road censuses of small upland birds, the production of grebes and coots, and the numbers of nests located. These data suggest that reproductive and mortality rates for these birds probably did not differ between the two cover types, and that only the population sizes were different. Perhaps the low populations of non-waterfowl species in sagebrush-grassland were a result of limited food supplies, particularly among the small upland passerines which depend rather heavily on grasses for dietary items (Martin et al. 1951). Sagebrush plants reduced the visibility for small birds, and the limited visibility may have been another important factor regulating population sizes.

The slightly lower survival of ducklings in the sagebrush-grassland unit may also have been a matter of food supply. A reduction in some

major components of an aquatic food chain--phytoplankton, zooplankton, and submergents--was associated with a greater average turbidity in this unit.

Munro (1963) described the temporary potholes of the prairie pothole region as highly productive of waterfowl when in the vicinity of more permanent water. In contrast, the potholes in the present study were either dry or nearly so by the time the earliest broods appeared.

The number of dugouts was insufficient to permit any substantial conclusions. However, Gjersing (1971) pointed out the superiority of retention reservoirs over dugouts in breeding-pair use.

Retention reservoirs, then, were the mainstay of waterfowl productivity in the study units. Considering the seasonal decrease in water level, which was particularly rapid on the smaller retention reservoirs, construction of reservoirs having less than about 3 acres of water surface is not recommended where waterfowl are considered. These ponds, especially if they were relatively shallow, tended to become dry by late summer, implying a minimum of usefulness prior to that time.

Hook (1973) and McCarthy (1973) indicated that the incorporation of nesting islands into the design of artificial impoundments would serve to increase Canada goose populations on their breeding grounds. This recommendation was given further support by the observations of goose nest sites in the present study.

Only four fenced reservoirs were included in this study, three of

which cattle entered sometime during the grazing season. Receding water levels in the summer often made partial fencing ineffective in excluding cattle. Even if the fences had been effective in keeping out cattle and improving the upland vegetation, Keith's (1961) data indicated that the fenced area may have attracted predators as well as nesting ducks, resulting in reduced hatching success as compared with adjacent unfenced areas. Considering the initial cost, the maintenance necessitated by fluctuating water levels, and the reported decrease in hatching success in ungrazed cover, there is little to recommend partial fencing of ponds in this study area.

As an alternative to fencing, a rest-rotation grazing system utilizing fenced pastures already in existence would undoubtedly be a less costly means of encouraging greater waterfowl production (Gjersing 1971). Gjersing indicated that both breeding pairs and broods increased their numbers in response to periodic relief from grazing.

The introduction of stock ponds to the study units has undoubtedly modified the avian ecology of the areas where waterfowl production appeared to be essentially nil without the presence of permanent artificial impoundments. Nest success for waterfowl in the present study, and in Smith's (1953) study in the same habitat, was high when compared with that in a variety of other habitats. However, the increase in nesting waterfowl and a continued high success suggest that potential egg predators have probably not increased at a comparable rate.

An observed waterfowl nest density of about one nest per 100 acres in this study precluded any dependence by predators on nests as a substantial food source, even on a seasonal basis.

McKinney (1965), after reporting the results of many studies, concluded that the territorial dispersion of nesting waterfowl is primarily an anti-predator device and therefore has survival value. This was indicated in the present study where low nest density was associated with a high percent of nest success. Security for nesting waterfowl and their nests was based largely on the long distances between nests. This was particularly true in the grassland unit where the nesting cover was sparse at best. In the sagebrush-grassland unit, big sagebrush was an abundant cover species. This plant was apparently preferred nesting cover in that unit, and presumably waterfowl were not handicapped by any lack of cover for nesting.

APPENDIX

TABLE 11. TYPES AND LOCATIONS OF STUDY PONDS.

Study-pond no.	Bureau of Land Management no. and name	Type	Location
Grassland unit (T. 25 N., R. 29 E.)			
7G1		RR[1]	S ½ Sec. 7
7G2[2]	717, Maxine Ret. Res.	RR	NE ¼ Sec. 7
7G2[3]	557 (2), Stock-Water Res.	RR	NE ¼ Sec. 7
8G1	557 (3), Earth-Filled Dam	RR	SE ¼ SW ¼ Sec. 8
8G2		RR	NE ¼ SW ¼ Sec. 8
8G3		DO[4]	SW ¼ SE ¼ Sec. 8 + N ½ NE ¼ Sec. 17
8GA		NP[5]	SE ¼ SE ¼ Sec. 8
9G1		RR	NE ¼ Sec. 9
18G1		RR	NW ¼ Sec. 18
18G2		RR	NE ¼ Sec. 18
18G3	557 (4), PR-176, Earth-Filled Dam	RR	SE ¼ Sec. 18
19G1		RR	SW ¼ Sec. 19
19G2		RR	SE ¼ Sec. 19
20G1		RR	SW ¼ NW ¼ Sec. 20
20GA		NP	SE ¼ Sec. 20
20GB		NP	E ½ NW ¼ Sec. 20
20GC		NP	S ½ NE ¼ Sec. 20
28G1	374, PR-325	RR	SW ¼ NW ¼ Sec. 28
28G2	PR-325	RR	NE ¼ NW ¼ Sec. 28
28G3		DO	NE ¼ Sec. 28
28GA		NP	SE ¼ NW ¼ Sec. 28
28GB		NP	NW ¼ SW ¼ Sec. 28
28GC		NP	NE ¼ SW ¼ Sec. 28

TABLE 11. (CONTINUED)

Study-pond no.	Bureau of Land Management no. and name	Type	Location
Grassland unit (T. 25 N., R. 29 E.) (continued)			
28GD		NP	NE ¼ SW ¼ SE ¼ Sec. 28
28GE		NP	SW ¼ SW ¼ SE ¼ Sec. 28
29G1		RR	SW ¼ Sec. 29
29G2		DO	NW ¼ NE ¼ Sec. 29
29GA		NP	N ½ NE ¼ NE ¼ Sec. 29
29GB		NP	SW ¼ NE ¼ SE ¼ Sec. 29
29GC		NP	SE ¼ SE ¼ Sec. 29
29GD		NP	S ½ NE ¼ NE ¼ Sec. 29
30G1		RR	NE ¼ Sec. 30
Grassland fenced ponds			
G4	322, PR-147, Holzhey	RR	SE ¼ Sec. 23, T. 25 N., R. 28 E.
G5	324, PR-152	RR	SW ¼ Sec. 3, T. 24 N., R. 29 E.
Sagebrush-grassland unit (T. 23 N., R. 29 E.)			
10S1	552, Archie L. Res.	RR	NW ¼ Sec. 10
10S2		RR	SW ¼ Sec. 10
10S3	281	RR	NW ¼ Sec. 11
14S1		RR	SW ¼ SW ¼ Sec. 14
14S2		RR	SE ¼ SW ¼ Sec. 14
14S3	339, Carberry Res.	RR	NE ¼ Sec. 14
14SC		PC[6]	SW ¼ Sec. 14
15S1	431, Carberry Res.	RR	SW ¼ Sec. 15

TABLE 11. (CONTINUED)

Study-pond no.	Bureau of Land Management no. and name	Type	Location
Sagebrush-grassland unit (T. 23 N., R. 29 E.) (continued)			
15S2	1821, Hardy Res.	RR	SE ¼ Sec. 15
16S1		RR	NW ¼ Sec. 16
16S2		RR	SE ¼ Sec. 16
22S1	1841, Wet Res.	RR	SE ¼ Sec. 22
23S1	553, Snowball Res.	RR	SW ¼ Sec. 23
23S2		RR	NE ¼ Sec. 23
23SC		PC	E ½ Sec. 23
26S1	1808, Black Pit	RR	NW ¼ Sec. 26
26S2		RR	SE ¼ Sec. 26
27S1		RR	SW ¼ Sec. 27
27S2	605	RR	SE ¼ Sec. 27
Sagebrush-grassland fenced ponds			
S2		RR	SE ¼ Sec. 21, T. 26 N., R. 30 E.
S3	129, PR-18	RR	NW ¼ Sec. 5, T. 25 N., R. 30 E.

[1]Retention reservoir.
[2]North part.
[3]South part.
[4]Dugout (no. 8G3 consists of two borrow pits crossing a natural pothole).
[5]Natural pothole.
[6]Portion of creek adjacent to retention reservoir.

TABLE 12. COMPARISONS OF CANOPY COVERAGE AND FREQUENCY BETWEEN THE TWO VEGETATIONAL TYPES.

Plant or bare ground		Percent canopy coverage		Percent frequency[1]	
Latin name	Common name	G[2]	S[3]	G	S
SHRUBS					62.5
Artemisia cana	Silver Sagebrush	+[4]			
Artemisia tridentata	Big Sagebrush		17.9		62.5
Sarcobatus vermiculatus	Greasewood		+		
GRASSES				100.0	100.0
Agropyron smithii	Bluestem	14.8	15.1	82.5	65.0
Aristida longiseta	Red Three-awn	+			
Bouteloua gracilis	Blue Grama	15.0	17.0	82.5	82.5
Bromus tectorum	Downy Chess Brome	0.1		2.5	
Festuca octoflora	Six-weeks Fescue	1.6		15.0	
Koeleria cristata	Junegrass	9.4	1.8	80.0	22.5
Muhlenbergia cuspidata	Plains Muhly		+		
Poa secunda	Sandberg Bluegrass	12.5	4.9	40.0	70.0
Schedonnardus paniculatus	Tumblegrass		0.5		20.0
Sitanion hystrix	Squirreltail		0.1		5.0
Sporobolus cryptandrus	Sand Dropseed	+	0.4		5.0
Stipa comata	Needle-and-thread	31.9	1.7	90.0	17.5
Stipa viridula	Green Needlegrass	+	0.4		2.5

TABLE 12. (CONTINUED)

Plant or bare ground		Percent canopy coverage		Percent frequency	
Latin name	Common name	G	S	G	S
FORBS				100.0	97.5
Achillea millefolium	Yarrow	2.0	+	7.5	
Allium textile	Onion	0.1	0.3	2.5	12.5
Androsace septentrionalis	Northern Androsace	0.1		2.5	
Antennaria parvifolia	Small-leaf Pussytoes	+			
Arabis holboellii pendulocarpa	Holboell Rockcress	0.1	+	5.0	
Artemisia frigida	Fringed Sagewort	3.9	2.0	57.5	30.0
Artemisia ludoviciana	Cudweed Sagewort	+	+		
Aster canescens	Hoary Aster		+		
Aster pansus	Aster	+	0.1		2.5
Astragalus dasyglottis	Purple Milkvetch	+	0.1		5.0
Astragalus lotiflorus	Milkvetch	+			
Astragalus missouriensis	Missouri Milkvetch	0.2		10.0	
Astragalus purshii	Pursh Loco	0.1		2.5	
Atriplex argentea	Silverscale Saltbush		+		
Atriplex nuttallii	Nuttall Saltbush	+	0.6		10.0
Carex eleocharis	Needleleaf Sedge	4.9	3.4	75.0	30.0
Chenopodium album	Lamb's Quarter	+	0.1		5.0
Cirsium undulatum	Wavyleaf Thistle	+			

TABLE 12. (CONTINUED)

Plant or bare ground		Percent canopy coverage		Percent frequency	
Latin name	Common name	G	S	G	S
FORBS (CONTINUED)					
Collomia linearis	Narrow-leaved Collomia		+		
Erigeron canadensis	Horseweed Fleabane	+			
Erigeron pumilus	Fleabane	0.1	+	5.0	
Erysimum sp.	Wallflower		+		
Eurotia lanata	Winterfat	0.1	0.1	2.5	2.5
Grindelia squarrosa	Curlcup Gumweed	+	+		
Gutierrezia sarothrae	Broom Snakeweed	+	2.1		22.5
Haplopappus spinulosus	Spiny Goldenweed	+			
Hedeoma hispida	Rough False Pennyroyal	1.2	0.1	50.0	2.5
Lactuca serriola	Lettuce	+			
Lepidium densiflorum	Prairie Pepperweed	0.2	0.7	7.5	27.5
Liatris punctata	Dotted Blazingstar	+			
Linum rigidum	Stiffstem Flax	0.3	0.1	12.5	5.0
Mamillaria vivipara	Pink Pincushion Cactus	+	+		
Melilotus spp.	Sweetclover	+	+		
Opuntia polyacantha	Plains Pricklypear	0.1	1.8	2.5	20.0
Orobanche fasciculata	Tufted Broomrape	+			
Pedicularis sp.	Lousewort	+			
Penstemon albidus	White Penstemon	0.1	0.1	2.5	2.5
Petalostemum purpureum	Purple Prairie-clover		+		
Phlox hoodii	Hood's Phlox	1.2	0.4	22.5	15.0
Plantago elongata	Slender Plantain	0.1	0.2	5.0	10.0

TABLE 12. (CONTINUED)

Plant or bare ground		Percent canopy coverage		Percent frequency	
Latin name	Common name	G	S	G	S
FORBS (CONTINUED)					
Plantago purshii	Woolly Plaintain	0.2	+	7.5	
Plantago spinulosa	Spindle Plantain	0.4	1.2	17.5	50.0
Polygonum achoreum	Knotweed	+	0.2		7.5
Potentilla pensylvanica	Pennsylvania Cinquefoil	+			
Psoralea argophylla	Silverleaf Scurfpea	+	+		
Ratibida columnifera	Prairie Coneflower	+	+		
Solidago mollis	Goldenrod	+			
Sphaeralcea coccinea	Scarlet Globemallow	2.9	0.3	80.0	12.5
Taraxacum spp.	Dandelion	1.2	+	37.5	
Tragopogon dubius	Common Salsify	1.2	0.2	25.0	7.5
Vicia americana	American Vetch	0.8	1.1	17.5	17.5
Undetermined forbs		0.3	0.1	12.5	2.5
CRYPTOGAMS				100.0	92.5
Subclass Homobasidiomycetidae	Mushrooms and puffballs	0.1	0.1	2.5	2.5
Division Eumycophyta	Lichens	3.4	5.8	90.0	92.5
Selaginella densa	Clubmoss	24.3	4.2	82.5	32.5
LITTER		73.8	46.8	100.0	100.0
BARE GROUND				95.0	97.5
Bare soil		11.9	32.4	95.0	97.5
Rock		0.5	1.9	7.5	12.5

[1] Percent of plots in which the item was found. [2] Grassland study unit.
[3] Sagebrush-grassland study unit.
[4] Indicates occurrence in the stand but not encountered in the plots.

TABLE 13. BLOOMING DATES AND OCCURRENCE OF FORBS AND SHRUBS ON THE STUDY UNITS, 1971 AND 1972.

Latin name	Common name	Blooming dates[1] 1971	Blooming dates[1] 1972	Occurrence[2]	
ALISMACEAE	Water-plantain Family				
Alisma plantago-aquatica	American Water-plantain	Jul 10[3]-Aug 10	Jun 26 -Sep 12	G	S
Sagittaria cuneata	Arum-leaved Arrowleaf	Jun 28 -Sep 16	Jun 13[3]-Sep 12	G	S
LILIACEAE	Lily Family				
Allium textile	Onion	May 13 -Jun 7	May 15 -Jun 7	G	S
Fritillaria pudica	Yellow Bell	---	Apr 22 -Apr 22	G	
Zygadenus paniculatus	Foothill Death Camas	May 26 -Jun 23	May 29 -Jun 26	G	S
SANTALACEAE	Sandalwood Family				
Comandra umbellata	Pale Bastard Toadflax	---	May 19 -May 19		S
POLYGONACEAE	Buckwheat Family				
Eriogonum caespitosum	Mat Eriogonum	---	Jun 7 -Sep 2		S
Eriogonum flavum	Yellow Eriogonum	Jun 16 -Jun 16	---	G	
Polygonum coccinewm	Colored Smartweed	Jun 28 -Aug 18	Jun 26 -Sep 6	G	S
CHENOPODIACEAE	Goosefoot Family				
Atriplex nuttalliі	Nuttall Saltbush	---	Jun 17 -Jun 17	G	S
Chenopodium album	Lamb's Quarter	---	Jun 13 -Jul 1	G	S
Eurotia lanata	Winterfat	Jun 14 -Jun 22	---	G	S
CARYOPHYLLACEAE	Pink Family				
Cerastium arvense	Field Chickweed	May 19 -Jun 19	May 12 -Jun 20	G	
RANUNCULACEAE	Buttercup Family				
Ranunculus cymbalaria	Shore Buttercup	May 29 -Jun 15	May 22 -Jun 7		S
Ranunculus glaberrimus	Sagebrush Buttercup	Apr 12 -May 3	Apr 14 -May 8	G	S
Ranunculus subrigidus	Coil Buttercup	---	Jun 20[3]-Jul 28	G	S
CRUCIFERAE	Mustard Family				
Camelina microcarpa	Littlepod Falseflax	May 29 -Jun 3	May 23 -Jun 17	G	S
Conringia orientalis	Hare's Ear Mustard	Jun 3[3]-Jun 3	Jun 2 -Jun 5		S
Descurainia sophia	Flixweed Tansymustard	Jun 4[3]-Jun 18	May 22[3]-Sep 9	G	S
Draba sp.	Draba	---	Jun 3[3]-Jun 3	G	
Erysimum repandum	Repand Wallflower	---	Jun 13[3]-Jun 13	G	
Lepidium densiflorum	Prairie Pepperweed	---	Jun 2[3]-Jun 16	G	S
Lesquerella ludoviciana	Silver Bladderpod	May 6 -May 24	May 9 -May 18	G	S
Sisymbrium altissimum	Tumblemustard	---	Jun 3[3]-Sep 9	G	S
Thlaspi arvense	Fanweed	May 10 -Jun 28	May 4 -Jun 20	G	S

TABLE 13. (CONTINUED)

Latin name	Common name	Blooming dates 1971	Blooming dates 1972	Occurrence	
GROSSULARIACEAE	Currant and Gooseberry Family				
Ribes aureum	Golden Currant	May 10 -May 27	May 4 -May 23	G	S
ROSACEAE	Rose Family				
Potentilla gracilis	Northwest Cinquefoil	Jun 19 -Jul 10	Jun 13 -Jun 20	G	
Potentilla pensylvanica	Pennsylvania Cinquefoil	---	Jun 13 -Jul 22	G	
Rosa arkansana	Prairie Rose	---	Jul 8[3]-Sep 2		S
Rosa woodsii	Woods Rose	Jun 6 -Jun 30	Jun 2 -Jul 1	G	S
LEGUMINOSAE	Pea Family				
Astragalus bisulcatus	Two-grooved Milkvetch	May 27 -Jun 30	Jun 2 -Jul 8	G	S
Astragalus dasyglottis	Purple Milkvetch	May 18 -Jun 30	May 19 -Jun 26	G	S
Astragalus gilviflorus	Threeleaved Milkvetch	May 5 -May 26	May 3 -May 19	G	S
Astragalus missouriensis	Missouri Milkvetch	May 10 -Jun 17	May 18 -Jun 20	G	S
Astragalus pectinatus	Narrowleaf Poisonvetch	May 24 -Jun 7	May 24 -Jun 5	G	
Astragalus purshii	Pursh Loco	May 11 -May 19	May 3 -May 18	G	S
Astragalus striatus	Prairie Milkvetch	Jun 9 -Jun 19	---	G	
Glycyrrhiza lepidota	Wild Licorice	Jul 8 -Jul 23	Jul 1 -Aug 3	G	S
Medicago falcata	Yellow-flowered Alfalfa	Jun 17 -Jul 15	Jun 15 -Aug 29	G	S
Medicago lupulina	Black Medic	---	Jun 13[3]-Jun 13	G	
Medicago sativa	Alfalfa	Jun 3 -Aug 21	Jun 5 -Sep 13	G	S
Melilotus alba	White Sweetclover	---	Jul 1 -Sep 13	G	S
Melilotus officinalis	Yellow Sweetclover	Jun 3 -Aug 25	Jun 2 -Sep 22	G	S
Oxytropis lambertii	Purple Pointloco	Jun 16 -Jun 28	Jun 13 -Jun 13	G	
Oxytropis sericea	White Pointloco	May 10 -Jun 3	May 18 -Jun 2	G	S
Petalostemum purpureum	Purple Prairie-clover	Jul 15 -Jul 23	Jun 27 -Jul 15	G	S
Psoralea argophylla	Silverleaf Scurfpea	Jun 22 -Aug 25	Jun 26 -Sep 13	G	S
Thermopsis rhombifolia	Prairie Thermopsis	May 3 -Jun 17	Apr 27 -Jun 5	G	S
Vicia americana	American Vetch	May 10 -Jun 28	May 4 -Jun 26	G	S
LINACEAE	Flax Family				
Linum rigidum	Stiffstem Flax	---	Jun 13[3]-Aug 26	G	S
MALVACEAE	Mallow Family				
Sphaeralcea coccinea	Scarlet Globemallow	May 25 -Aug 6	Jun 2 -Sep 22	G	S

TABLE 13. (CONTINUED)

Latin name	Common name	Blooming dates 1971	Blooming dates 1972	Occurrence	
VIOLACEAE	Violet Family				
Viola nuttallii	Nuttall Violet	May 5 -May 10	May 17 -Jun 2	G	S
CACTACEAE	Cactus Family				
Mamillaria missouriensis	Yellow Pincushion Cactus	---	Jun 2 -Jun 2		S
Mamillaria vivipara	Pink Pincushion Cactus	Jun 14 -Jun 30	Jun 15 -Jun 20	G	S
Opuntia polyacantha	Plains Pricklypear	Jun 14 -Jul 13	Jun 12 -Jul 11	G	S
ONAGRACEAE	Evening Primrose Family				
Gaura coccinea	Scarlet Gaura	Jun 3 -Jun 30	Jun 9 -Aug 26	G	S
Oenothera biennis	Rydberg's Evening Primrose	Jul 15 -Jul 15	---		S
Oenothera caespitosa	Tufted Evening Primrose	May 13 -Jun 15	May 12 -Jun 12	G	S
UMBELLIFERAE	Carrot Family				
Cymopterus acaulis	Stemless Cymopterus	Apr 24 -May 13	Apr 6 -May 19	G	S
Musineon divaricatum		Apr 21 -May 29	Apr 6 -Jun 15	G	S
ASCLEPIADACEAE	Milkweed Family				
Asclepias speciosa	Showy Milkweed	Jun 28 -Jul 23	Jun 15 -Jul 28	G	S
Asclepias verticillata	Milkweed	Jul 15 -Jul 15	---		S
CONVOLVULACEAE	Morning Glory Family				
Convolvulus arvensis	Field Bindweed	Jun 10 -Aug 9	Jun 15 -Sep 9	G	S
Convolvulus sepium	Large Bindweed	Jul 23 -Jul 23	---		S
POLEMONIACEAE	Phlox Family				
Collomia linearis	Narrow-leaved Collomia	---	May 22 -Jun 16	G	S
Navarretia intertexta		---	Jun 20[3]-Jun 26	G	
Phlox hoodii	Hood's Phlox	Apr 21 -May 21	Apr 6 -Jun 3	G	S
BORAGINACEAE	Borage Family				
Cryptantha interrupta	Miner's Candle	May 24 -Jun 16	---	G	S
Lappula redowskii	Western Stick Tight	May 18 -Jun 15	May 19 -Jun 16	G	S
Plagiobothrys scouleri		---	Jun 3[3]-Aug 5	G	S
VERBENACEAE	Verbena Family				
Verbena bracteata	Bracted Verbena	---	Jul 14[3]-Sep 22	G	
LABIATAE	Mint Family				
Mentha arvensis	Field Mint	---	Aug 5[3]-Sep 12	G	S

TABLE 13. (CONTINUED)

Latin name	Common name	Blooming dates 1971	Blooming dates 1972	Occurrence	
SOLANACEAE	Potato Family				
Solanum triflorum	Cut-leaved Nightshade	---	Jun 26[3]-Jun 26	G	
SCROPHULARIACEAE	Figwort Family				
Bacopa rotundifolia	Wet Water Hyssop	---	Jul 14[3]-Jul 14	G	
Pedicularis sp.	Lousewort	---	Jun 26 -Sep 9	G	
Penstemon albidus	White Penstemon	May 29 -Jun 28	May 31 -Jun 16	G	S
Penstemon gracilis	Slender Penstemon	Jun 19 -Jun 19	Jun 13 -Jun 26	G	
Penstemon nitidus	Waxleaf Penstemon	May 10 -Jun 15	May 10 -Jun 7		S
OROBANCHACEAE	Broomrape Family				
Orobanche fasciculata	Tufted Broomrape	Jun 18[3]-Jun 28	Jun 13 -Jun 20	G	
LENTIBULARIACEAE	Bladderwort Family				
Utricularia vulgaris	Common Bladderwort	Jul 19[3]-Aug 3	---	G	
PLANTAGINACEAE	Plantain Family				
Plantago spinulosa	Spindle Plantain	---	Jun 13 -Jul 1	G	S
CAPRIFOLIACEAE	Honeysuckle Family				
Symphoricarpos occidentalis	Western Snowberry	Jul 15[3]-Jul 23	Jun 15 -Aug 10		S
COMPOSITAE	Composite Family				
Achillea millefolium	Yarrow	May 29 -Jul 16	Jun 1 -Aug 5	G	S
Agoseris glauca	Pale Agoseris	---	Jun 17 -Jul 1	G	S
Antennaria parvifolia	Small-leaf Pussytoes	May 18 -Jun 15	May 18 -Jun 13	G	S
Antennaria rosea	Rose Pussytoes	May 22 -Jun 19	---	G	S
Arnica sororia	Arnica	---	Jun 2 -Jun 20	G	
Artemisia frigida	Fringed Sagewort	---	Aug 25 -Sep 13	G	S
Artemisia tridentata	Big Sagebrush	Sep 15 -Sep 16	Sep 9 -Sep 22		S
Aster canescens	Hoary Aster	May 27 -Jul 30	May 22 -Sep 22	G	S
Aster pansus	Aster	---	Jul 31 -Sep 22	G	S
Chrysopsis villosa	Golden-aster	---	Jul 28[3]-Jul 28	G	
Chrysothamnus nauseosus	Rubber Rabbitbrush	Aug 16 -Sep 15	Jul 29 -Sep 22	G	S
Cirsium arvense	Canada Thistle	Jun 28 -Sep 10	Jun 27 -Sep 12	G	S
Cirsium undulatum	Wavyleaf Thistle	Jun 17 -Sep 11	Jun 17 -Sep 22	G	S
Coreopsis tinctoria	Plains Tickseed	Jul 12 -Aug 25	Jul 18 -Sep 12	G	S
Erigeron pumilus	Fleabane	May 24 -Jul 13	May 22 -Jul 3	G	S

TABLE 13. (CONTINUED)

Latin name	Common name	Blooming dates 1971	Blooming dates 1972	Occurrence	
COMPOSITAE (continued)					
Gaillardia aristata	Gaillardia	Jun 18 -Jun 30	Jun 13 -Jun 26	G	
Grindelia squarrosa	Curlcup Gumweed	Jul 13 -Sep 18	Jun 13 -Sep 22	G	S
Gutierrezia sarothrae	Broom Snakeweed	Jul 30 -Sep 18	Jul 22 -Sep 22	G	S
Helianthus annuus	Common Sunflower	Jun 15 -Sep 16	Jun 15 -Sep 13	G	S
Helianthus maximiliani	Maximilian Sunflower	Aug 3 -Sep 2	Aug 5[3]-Sep 12	G	S
Hymenoxys richardsonii		May 29 -Jun 17	Jun 5[3]-Jun 16		S
Lactuca pulchella	Blue Lettuce	Jun 17 -Aug 23	Jun 27 -Jul 11	G	S
Liatris punctata	Dotted Blaxingstar	Aug 3 -Sep 17	Jul 31 -Sep 9	G	S
Lygodesmia juncea	Rush Skeletonweed	Jun 23 -Aug 17	Jun 26 -Sep 9	G	S
Microseris cuspidata		May 11 -May 26	May 15 -Jun 1	G	S
Ratibida columnifera	Prairie Coneflower	Jun 25 -Sep 2	Jun 26 -Sep 22	G	S
Senecio integerrimus	Lamb's Tongue Groundsel	Jun 2[3]-Jun 7	Jun 1 -Jun 5	G	
Solidago missouriensis	Goldenrod	---	Jul 14 -Aug 26	G	S
Solidago mollis	Goldenrod	Jul 26 -Aug 21	Jul 28 -Aug 22	G	S
Sonchus uliginosus	Sowthistle	Jul 15 -Aug 16	---	G	S
Taraxacum laevigatum	Smooth Dandelion	Apr 28 -Jul 16	Apr 24 -Sep 2	G	S
Taraxacum officinale	Common Dandelion	---	May 19[3]-Sep 12	G	S
Tragopogon dubius	Common Salsify	May 27 -Jul 16	Jun 3 -Sep 6	G	S

[1]Date the first blossom was seen-date the last one was seen, for the periods April 6 to September 18, 1971, and March 21 to September 22, 1972.
[2]Found in grassland unit (G), in sagebrush-grassland unit (S), or in both.
[3]Presence of fruits indicated blooming prior to this date.

TABLE 14. CANOPY COVERAGE AND FREQUENCY OF PLANTS ON EACH SIDE OF THE FENCE AT A SAGEBRUSH-GRASSLAND FENCED POND, BASED ON 20 PLOTS ON EACH SIDE.

Plant or bare ground		Percent canopy coverage		Percent frequency[1]	
Latin name	Common name	Outside	Inside	Outside	Inside
SHRUBS				30.0	15.0
Artemisia tridentata	Big Sagebrush	7.4	1.9	30.0	5.0
Chrysothamnus nauseosus	Rubber Rabbitbrush	+[2]	0.9		10.0
GRASSES				90.0	80.0
Agropyron smithii	Bluestem	9.2	0.9	35.0	10.0
Aristida longiseta	Red Three-awn		+		
Bouteloua gracilis	Blue Grama	12.1	9.5	75.0	60.0
Distichlis stricta	Desert Saltgrass	0.2	4.9	10.0	25.0
Festuca octoflora	Six-weeks Fescue	0.2	+	10.0	
Koeleria cristata	Junegrass	0.8	5.2	5.0	20.0
Muhlenbergia cuspidata	Plains Muhly		1.2		25.0
Poa secunda	Sandberg Bluegrass	4.4	2.0	50.0	30.0
Schedonnardus paniculatus	Tumblegrass		0.1		5.0
Sitanion hystrix	Squirreltail		0.8		5.0
Sporobolus cryptandrus	Sand Dropseed	0.2	1.0	10.0	15.0
Stipa comata	Needle-and-thread		+		
Undetermined grass			+		
FORBS				90.0	90.0
Achillea millefolium	Yarrow		0.1		5.0
Arabis holboellii pendulocarpa	Holboell Rockcress	+			
Artemisia frigida	Fringed Sagewort	0.2	0.9	10.0	10.0

TABLE 14. (CONTINUED)

Plant or bare ground		Percent canopy coverage		Percent frequency	
Latin name	Common name	Outside	Inside	Outside	Inside
FORBS (CONTINUED)					
Aster pansus	Aster		1.9		5.0
Astragalus striatus	Prairie Milkvetch		+		
Atriplex argentea	Silverscale Saltbush	+	0.2		10.0
Atriplex nuttallii	Nuttall Saltbush	+	0.8		5.0
Carex brevior	Short-beak Sedge		+		
Carex eleocharis	Needleleaf Sedge	1.8	0.8	20.0	5.0
Chenopodium album	Lamb's Quarter		+		
Erigeron pumilus	Fleabane	+			
Eriogonum caespitosum	Mat Eriogonum	6.8	0.6	50.0	25.0
Grindelia squarrosa	Curlcup Gumweed	+	0.2		10.0
Gutierrezia sarothrae	Broom Snakeweed	1.1	0.8	20.0	5.0
Hedeoma hispida	Rough False Pennyroyal	0.2		10.0	
Hymenoxys richardsonii		0.1	+	5.0	
Lepidium densiflorum	Prairie Pepperweed	0.2	0.5	10.0	20.0
Linum rigidum	Stiffstem Flax	0.1		5.0	
Lomatium sp.		0.8		5.0	
Opuntia polyacantha	Plains Pricklypear	1.5	1.0	10.0	15.0
Petalostemum purpureum	Purple Prairie-clover		+		
Phlox hoodii	Hood's Phlox	0.1		5.0	
Plantago elongata	Slender Plantain		0.1		5.0
Plantago spinulosa	Spindle Plantain	0.9	0.4	35.0	15.0

TABLE 14. (CONTINUED)

Plant or bare ground		Percent canopy coverage		Percent frequency	
Latin name	Common name	Outside	Inside	Outside	Inside
FORBS (CONTINUED)					
Polygonum achoreum	Knotweed	0.6	1.2	25.0	25.0
Psoralea argophylla	Silverleaf Scurfpea		+		
Ratibida columnifera	Prairie Coneflower		+		
Salsola kali	Russian Thistle		+		
Sphaeralcea coccinea	Scarlet Globemallow		0.2		10.0
Taraxacum spp.	Dandelion		+		
Thermopsis rhombifolia	Prairie Thermopsis	+	1.9		5.0
Vicia americana	American Vetch		+		
Undetermined forbs		0.1	0.9	5.0	35.0
CRYPTOGAMS				95.0	85.0
Division Eumycophyta	Lichens	4.2	3.4	95.0	85.0
Selaginella densa	Clubmoss	4.4	1.9	30.0	25.0
LITTER		30.5	24.5	100.0	100.0
BARE GROUND				100.0	100.0
Bare soil		60.5	69.6	100.0	100.0
Rock		2.8		15.0	

[1] Percent of plots in which the item was found.
[2] Indicates occurrence in the stand but not encountered in the plots.

TABLE 15. DATES AND ABUNDANCE OF BIRDS OBSERVED ON AND NEAR THE STUDY UNITS, 1970-1972.

Species	1970 Dates[1]	1970 Abun.[2] G	1970 Abun. S	1971 Dates	1971 Abun. G	1971 Abun. S	1972 Dates	1972 Abun. G	1972 Abun. S
Horned Grebe, *Podiceps auritus*	---	--	--	Apr 19-Jun 16	4	--	Apr 26-Aug 15	15	3
Eared Grebe, *Podiceps caspicus*	Jul 18-Sep 25	6	5	Apr 16-Sep 18	7	5	Apr 28-Aug 29	2	7
Pied-Billed Grebe, *Podilymbus podiceps*	Jun 9-Sep 22	17	7	Apr 24-Sep 18	19	7	Apr 25-Sep 12	7	6
White Pelican, *Pelecanus erythrorhynchos*	Jun 24-Jun 24	--	--	Apr 30-Jun 24	--	--	Apr 22-Jun 15	2	1
Double-Crested Cormorant, *Phalacrocorax auritus*	Jun 8-Aug 19	--	2	Apr 25-Apr 25	--	--	Jun 7-Sep 13	0	3
Great Blue Heron, *Ardea herodias*	Jun 9-Sep 12	--	3	Apr 23-Sep 14	3	1	May 19-Sep 11	4	4
Black-Crowned Night Heron, *Nyticorax nyticorax*	---	--	--	---	--	--	Jul 7-Jul 7	1	0
American Bittern, *Botaurus lentiginosus*	Jul 8-Aug 27	2	--	Jul 9-Aug 25	3	--	May 24-Sep 14	1	3
Whistling Swan, *Olor columbianus*[3]	---	--	--	Apr 2-Apr 2	--	--	---	--	--
Canada Goose, *Branta canadensis*	Jun 22-Sep 12	4	1	Apr 1-Sep 30	33	11	Mar 21-Sep 12	28	14
Mallard, *Anas platyrhynchos*	Jun 22-Sep 25	18	16	Apr 1-Sep 18	55	37	Mar 21-Sep 22	59	37
Gadwall, *Anas strepera*	Jun 22-Sep 25	16	7	Apr 13-Sep 18	37	21	Mar 25-Oct 7	51	28
Pintail, *Anas acuta*	Jun 22-Sep 25	17	5	Apr 1-Sep 18	60	22	Mar 21-Sep 22	54	25
Green-Winged Teal, *Anas carolinensis*	Aug 14-Sep 25	2	3	Apr 6-Sep 16	26	8	Mar 21-Sep 13	17	17
Blue-Winged Teal, *Anas discors*	Jun 22-Sep 25	17	16	Apr 23-Sep 20	40	19	Apr 25-Sep 29	43	25
Cinnamon Teal, *Anas cyanoptera*	Jun 30-Jun 30	1	0	Apr 24-Apr 24	0	1	May 3-Jun 8	3	2

TABLE 15. (CONTINUED)

Species	1970 Dates	1970 Abun. G	1970 Abun. S	1971 Dates	1971 Abun. G	1971 Abun. S	1972 Dates	1972 Abun. G	1972 Abun. S
American Widgeon, *Mareca americana*	Jun 22-Sep 25	16	17	Apr 7-Sep 18	49	36	Mar 21-Sep 22	53	43
Shoveler, *Spatula clypeata*	Jun 22-Sep 25	18	7	Apr 6-Sep 18	42	10	Apr 14-Sep 2	43	10
Redhead, *Aythya americana*	---	--	--	Apr 5-Aug 25	14	3	Mar 23-Jul 3	10	7
Ring-Necked Duck, *Aythya collaris*[3]	Aug 19-Aug 19	0	1	Aug 17-Aug 17	1	0	Apr 27-Apr 27	0	1
Canvasback, *Aythya valisineria*	Jul 21-Sep 4	--	5	Apr 16-Aug 18	5	5	Apr 28-Jul 15	2	6
Lesser Scaup, *Aythya affinis*	Jun 22-Sep 25	9	9	Apr 7-Sep 18	30	25	Apr 4-Sep 12	32	24
Common Goldeneye, *Bucephala clangula*[3]	---	--	--	Apr 5-Apr 21	4	--	Mar 21-Apr 22	6	2
Bufflehead, *Bucephala albeola*[3]	---	--	--	Apr 13-May 4	3	--	Apr 11-Apr 28	1	1
	---	--	--	Sep 18-Sep 18	--	--	Oct 5-Oct 5	0	1
Ruddy Duck, *Oxyura jamaicensis*	Sep 11-Sep 25	2	0	May 21-Aug 17	7	2	Jun 28-Aug 8	0	2
Common Merganser, *Mergus merganser*[3]	---	--	--	Apr 14-Apr 14	0	1	Mar 23-Mar 23	0	1
Red-Breasted Merganser, *Mergus serrator*[3]	---	--	--	Apr 5-Apr 14	--	1	---	--	--
Red-Tailed Hawk, *Buteo jamaicensis*	---	--	--	Apr 22-Aug 16	--	2	Mar 21-Mar 21	0	1
Swainson's Hawk, *Buteo swainsoni*	Jul 17-Sep 9	4	2	Apr 27-Sep 11	5	4	May 3-Sep 9	25	5
Rough-Legged Hawk, *Buteo lagopus*[3]	---	--	--	---	--	--	Mar 25-Mar 31	1	--
Ferruginous Hawk, *Buteo regalis*	Sep 15-Sep 15	--	--	Sep 14-Sep 14	--	--	Apr 3-Apr 3	1	0

TABLE 15. (CONTINUED)

Species	1970 Dates	1970 Abun. G	1970 Abun. S	1971 Dates	1971 Abun. G	1971 Abun. S	1972 Dates	1972 Abun. G	1972 Abun. S
Golden Eagle, *Aquila chrysaetos*	Jun 21-Aug 31	--	2	Apr 8-Sep 20	1	3	Mar 23-Aug 29	6	9
Bald Eagle, *Haliaeetus leucocephalus*[3]	---	--	--	---	--	--	Mar 31-Mar 31	1	0
Marsh Hawk, *Circus cyaneus*	Jun 9-Sep 25	7	6	Apr 5-Sep 18	15	5	Mar 24-Oct 7	36	22
Prairie Falcon, *Falco mexicanus*	---	--	--	Apr 10-Sep 2	1	--	Jul 31-Jul 31	1	0
Pigeon Hawk, *Falco columbarius*	Sep 15-Sep 15	--	--	---	--	--	Aug 14-Sep 9	2	1
Sparrow Hawk, *Falco sparverius*	---	--	--	Apr 1-Sep 10	--	1	Mar 23-Sep 9	29	7
Sharp-Tailed Grouse, *Pedioecetes phasianellus*	---	--	--	May 18-Sep 18	1	1	Mar 29-Mar 29	--	--
Sage Grouse, *Centrocercus urophasianus*	Jun 10-Sep 9	2	5	Apr 7-Sep 16	8	12	Mar 21-Oct 7	9	15
Ring-Necked Pheasant, *Phasianus colchicus*	---	--	--	Apr 7-Sep 16	--	4	Mar 23-Jul 18	9	3
Gray Partridge, *Perdix perdix*	Jun 25-Aug 18	--	1	Apr 2-Sep 20	4	3	Mar 25-Sep 22	24	1
Sora, *Porzana carolina*	Jul 30-Jul 30	1	0	May 19-Jul 9	3	2	Jun 17-Jul 11	1	1
American Coot, *Fulica americana*	Jun 22-Sep 25	20	8	Apr 29-Sep 18	30	3	Apr 3-Sep 14	21	8
Killdeer, *Charadrius vociferus*	Jun 22-Sep 23	12	13	Apr 4-Sep 16	49	33	Mar 21-Oct 7	55	38
Black-Bellied Plover, *Squatarola squatarola*[3]	---	--	--	May 22-May 22	1	0	---	--	--
Common Snipe, *Capella gallinago*	Aug 17-Aug 17	0	1	---	--	--	Sep 13-Sep 13	0	1
Long-Billed Curlew, *Numenius americanus*	Jun 11-Aug 25	5	1	Apr 11-Aug 7	16	2	Apr 12-Jul 26	30	1

TABLE 15. (CONTINUED)

Species	1970 Dates	1970 Abun. G	1970 Abun. S	1971 Dates	1971 Abun. G	1971 Abun. S	1972 Dates	1972 Abun. G	1972 Abun. S
Upland Plover, *Bartramia longicauda*	---	--	--	---	--	--	Jun 1-Aug 22	2	3
Spotted Sandpiper, *Actitis macularia*	Jun 26-Sep 4	2	3	May 24-Sep 8	6	12	May 18-Aug 26	11	8
Willet, *Catoptrophorus semipalmatus*	Jun 9-Aug 17	5	4	May 3-Aug 21	30	11	Apr 22-Aug 29	36	19
Greater Yellowlegs, *Totanus melanoleucus*[3]	---	--	--	Apr 13-May 14	2	--	Apr 24-Apr 24	1	0
	---	--	--	Sep 13-Sep 13	--	--	Sep 5-Sep 5	0	1
Lesser Yellowlegs, *Totanus flavipes*[3]	---	--	--	Apr 28-May 11	2	--	Apr 24-Apr 26	3	0
	Jul 17-Sep 4	1	2	Jul 17-Sep 9	6	3	Aug 3-Sep 2	4	3
Least Sandpiper, *Erolia minutilla*[3]	Aug 31-Aug 31	0	1	Jul 12-Sep 14	--	2	Aug 8-Sep 2	2	2
Long-Billed Dowitcher, *Limodromus scolopaceus*[3]	---	--	--	Apr 26-May 12	5	--	May 3-May 3	0	1
	Aug 14-Aug 14	0	1	---	--	--	Aug 8-Aug 8	0	1
Marbled Godwit, *Limosa fedoa*	Jun 10-Jun 10	--	--	May 3-Aug 9	17	2	Apr 28-Aug 8	19	1
American Avocet, *Recurvirostra americana*	Jul 1-Aug 27	2	--	May 7-Jun 30	--	--	May 3-Aug 26	2	3
Wilson's Phalarope, *Steganopus tricolor*	Jun 8-Sep 4	6	6	May 3-Sep 10	30	10	Apr 28-Aug 14	28	10
California Gull, *Larus californicus*	---	--	--	Apr 26-Jul 12	3	1	Apr 24-Aug 9	7	3
Ring-Billed Gull, *Larus delawarensis*	Jul 17-Sep 9	1	4	Apr 14-Sep 8	3	2	Mar 24-Aug 7	2	2
Franklin's Gull, *Larus pipixcan*	---	--	--	---	--	--	Apr 22-Apr 22	1	0
Common Tern, *Sterna hirundo*	---	--	--	---	--	--	Jul 3-Jul 3	1	0

TABLE 15. (CONTINUED)

Species	1970 Dates	1970 Abun. G	1970 Abun. S	1971 Dates	1971 Abun. G	1971 Abun. S	1972 Dates	1972 Abun. G	1972 Abun. S
Black Tern, *Chlidonias niger*	Jun 8-Aug 24	4	2	May 21-Aug 17	8	4	May 17-Jun 28	1	1
Mourning Dove, *Zenaidura macroura*	Jul 16-Sep 9	--	4	Apr 5-Sep 16	2	15	Apr 27-Sep 13	38	22
Great Horned Owl, *Bubo virginianus*	Sep 4-Sep 4	0	1	---	--	--	Apr 3-May 23	9	1
Burrowing Owl, *Speotyto cunicularia*	Jun 20-Sep 17	1	--	Jun 20-Aug 25	--	--	Jun 5-Aug 15	0	4
Short-Eared Owl, *Asio flammeus*	---	--	--	Jun 9-Aug 10	3	--	Apr 25-Jul 15	6	0
Common Nighthawk, *Chordeiles minor*	Jun 23-Aug 31	2	1	May 22-Aug 27	5	7	May 31-Aug 22	19	8
Belted Kingfisher, *Megaceryle alcyon*	---	--	--	---	--	--	Jul 14-Aug 9	2	1
Yellow-Shafted Flicker, *Colaptes auratus*	---	--	--	---	--	--	Apr 24-Sep 6	2	0
Red-Shafted Flicker, *Colaptes cafer*	Jun 10-Jun 10	--	--	Apr 14-Aug 25	--	1	Apr 10-Apr 25	2	0
Red-Headed Woodpecker, *Melanerpes erythrocephalus*	---	--	--	---	--	--	May 24-Jun 5	--	--
Downy Woodpecker, *Dendrocopos pubescens*	---	--	--	---	--	--	May 4-May 4	0	1
Eastern Kingbird, *Tyrannus tyrannus*	Jun 9-Aug 18	2	6	May 26-Sep 2	11	11	May 19-Aug 22	24	16
Western Kingbird, *Tyrannus verticalis*	Aug 17-Aug 17	0	1	May 10-Aug 25	--	1	May 23-Aug 9	14	1
Say's Phoebe, *Sayornis saya*	---	--	--	May 4-May 11	2	0	May 4-Jun 29	2	1
Horned Lark, *Eremophila alpestris*	Jun 8 -Sep 25	15	8	Apr 1-Sep 20	47	17	Mar 21-Oct 7	60	35
Rough-Winged Swallow, *Stelgidopteryx ruficollis*	---	--	--	Jun 14-Jun 14	0	1	May 4-Aug 8	2	4

TABLE 15. (CONTINUED)

Species	1970 Dates	1970 Abun. G	1970 Abun. S	1971 Dates	1971 Abun. G	1971 Abun. S	1972 Dates	1972 Abun. G	1972 Abun. S
Barn Swallow, *Hirundo rustica*	Jun 11-Sep 4	1	7	May 10-Sep 9	5	5	May 12-Sep 2	18	10
Cliff Swallow, *Petrochelidon pyrrhonota*	Jun 22-Jun 22	--	--	May 16-Aug 18	7	2	May 12-Aug 3	14	2
Black-Billed Magpie, *Pica pica*	Jul 22-Aug 18	0	2	May 29-Sep 16	--	--	Mar 21-Aug 9	3	4
Common Crow, *Corvus brachyrhynchos*	---	--	--	Apr 26-Apr 26	1	0	Apr 7-Sep 28	2	--
House Wren, *Troglodytes aedon*	---	--	--	Jul 23-Jul 23	0	1	---	--	--
Brown Thrasher, *Toxostoma rufum*	---	--	--	May 20-Jul 23	--	--	May 22-Jun 27	1	1
Robin, *Turdus migratorius*	---	--	--	Apr 22-Jul 23	--	4	---	--	--
Mountain Bluebird, *Sialia currucoides*	---	--	--	---	--	--	Jun 16-Jun 16	1	0
Water Pipit, *Anthus spinoletta*[3]	---	--	--	---	--	--	Apr 24-Apr 24	1	0
Sprague's Pipit, *Anthus spragueii*	Jul 18-Sep 25	2	1	Apr 29-Sep 2	8	1	Apr 26-Jul 26	20	1
Loggerhead Shrike, *Lanius ludovicianus*	Jul 9-Jul 22	--	1	May 3-Aug 27	2	1	Apr 27-Aug 22	24	9
Starling, *Sturnus vulgaris*	Aug 17-Sep 17	4	2	Apr 9-Aug 27	7	4	Mar 21-Oct 7	8	1
Yellow Warbler, *Dendroica petechia*	---	--	--	Jun 28-Jul 15	1	1	---	--	--
Myrtle Warbler, *Dendroica coronata*[3]	---	--	--	---	--	--	May 4-May 23	0	2
	---	--	--	---	--	--	Sep 14-Sep 14	0	1
Yellowthroat, *Geothlypis trichas*	---	--	--	May 22-Jul 15	0	2	May 17-Jun 15	1	3

TABLE 15. (CONTINUED)

Species	1970 Dates	1970 Abun. G	1970 Abun. S	1971 Dates	1971 Abun. G	1971 Abun. S	1972 Dates	1972 Abun. G	1972 Abun. S
House Sparrow, *Passer domesticus*	---	--	--	Apr 1-Sep 13	4	--	Mar 21-Oct 7	45	0
Western Meadowlark, *Sturnella neglecta*	Jul 16-Sep 25	8	7	Apr 5-Sep 20	41	28	Mar 21-Oct 7	55	39
Yellow-Headed Blackbird, *Xanthocephalus xanthocephalus*	Jul 20-Sep 17	3	1	Apr 22-Sep 10	11	8	Apr 22-Sep 9	34	8
Red-Winged Blackbird, *Agelaius phoeniceus*	Jul 16-Sep 17	9	6	Apr 12-Sep 16	38	20	Mar 24-Oct 7	49	18
Bullock's Oriole, *Icterus bullockii*	---	--	--	Jun 3-Jun 28	1	1	---	--	--
Brewer's Blackbird, *Euphagus cyanocephalus*	Jul 18-Sep 17	4	1	May 6-Sep 20	5	7	Apr 25-Sep 22	32	4
Common Grackle, *Quiscalus quiscula*	Jul 16-Jul 29	3	1	May 3-May 27	1	2	---	--	--
Brown-Headed Cowbird, *Molothrus ater*	Jun 9-Sep 17	6	2	May 4-Jul 17	5	4	May 10-Oct 7	20	6
American Goldfinch, *Spinus tristis*	---	--	--	May 28-Aug 25	2	--	May 24-May 24	1	0
Rufous-Sided Towhee, *Pipilo erythrophthalmus*	---	--	--	---	--	--	May 17-May 17	1	0
Lark Bunting, *Calamospiza melanocorys*	Jun 9-Jul 29	2	1	May 6-Aug 19	4	--	May 12-Aug 22	29	17
Savannah Sparrow, *Passerculus sandwichensis*	---	--	--	May 3-Sep 2	10	2	May 8-Aug 26	14	1
Vesper Sparrow, *Pooecetes gramineus*	Jul 21-Sep 9	1	9	Apr 26-Sep 16	2	16	Apr 26-Sep 22	25	25
Lark Sparrow, *Chondestes grammacus*	Jul 16-Jul 16	--	--	May 29-Jul 23	1	--	May 19-May 25	1	1
Chipping Sparrow, *Spizella passerina*	---	--	--	May 24-Aug 3	1	--	May 4-May 16	2	1

TABLE 15. (CONTINUED)

Species	1970 Dates	1970 Abun. G	1970 Abun. S	1971 Dates	1971 Abun. G	1971 Abun. S	1972 Dates	1972 Abun. G	1972 Abun. S
Clay-Colored Sparrow, *Spizella pallida*	---	--	--	---	--	--	May 16-Jul 11	4	1
Brewer's Sparrow, *Spizella breweri*	---	--	--	---	--	--	May 19-Jun 17	0	6
White-Crowned Sparrow, *Zonotrichia leucophrys*[3]	---	--	--	May 8-May 8	1	0	May 16-May 16	1	0
Song Sparrow, *Melospiza melodia*	Jul 16-Sep 22	6	--	---	--	--	---	--	--
McCown's Longspur, *Rhynchophanes mccownii*	Jun 9-Jun 9	--	--	May 12-May 12	1	0	Apr 11-Apr 24	2	0
Chestnut-Collared Longspur, *Calcarius ornatus*	Jul 16-Sep 25	11	1	Apr 8-Sep 17	44	3	Apr 14-Sep 13	46	0

[1]Date the first individual was observed-date the last one was observed, for the periods June 8 to September 25, 1970; April 1 to September 20, 1971; and March 21 to October 7, 1972.
[2]In number of days the species was recorded in grassland (G) and sagebrush-grassland (S) units or cover types.
[3]A species observed out of its breeding range (Robbins, Bruun, and Zim 1966).

TABLE 16. BIRD NESTS FOUND IN EACH VEGETATIONAL TYPE (WATERFOWL NESTS EXCLUDED), 1971 AND 1972.

Species	Minimum number of eggs	Fate of nest
Grassland		
Horned Grebe	4	Hatched
Horned Grebe	3	Hatched
Horned Grebe	2	---
Pied-Billed Grebe	—	---
Swainson's Hawk	1	Hatched
Sharp-Tailed Grouse	10	Depredated
Sage Grouse	7	Depredated
American Coot	9	---
American Coot	8	Hatched
American Coot	2	Destroyed, probably by cattle
Killdeer	4	Depredated
Killdeer	4	---
Wilson's Phalarope	4	Hatched
Wilson's Phalarope	4	Hatched
Wilson's Phalarope	4	Depredated
Great Horned Owl	3	Addled
Horned Lark	3	---
Horned Lark	3	---
Horned Lark	3	---
Horned Lark	2	---
Horned Lark	1	Depredated
Horned Lark	1	Depredated
House Sparrow	—	Hatched
Western Meadowlark	3	---
Western Meadowlark	2	Hatched
Red-Winged Blackbird	3	---
Red-Winged Blackbird	3	---
Red-Winged Blackbird	3	Hatched
Red-Winged Blackbird	2	Hatched
Red-Winged Blackbird	2	---

TABLE 16. (CONTINUED)

Species	Minimum number of eggs	Fate of nest
Grassland (continued)		
Brewer's Blackbird	5	---
Brown-Headed Cowbird[1]	1	---
Brown-Headed Cowbird[1]	1	---
Chestnut-Collared Longspur	4	Hatched
Chestnut-Collared Longspur	4	Hatched
Sagebrush-grassland		
Sage Grouse	--	Depredated
Gray Partridge	11	Depredated
Willet	4	Accidentally destroyed by observer
Wilson's Phalarope	4	---
Mourning Dove	2	Deserted
Great Horned Owl	--	---
Common Nighthawk	2	---
Western Meadowlark	5	---
Western Meadowlark	--	Hatched
Red-Winged Blackbird	4	Hatched

[1] Parasitized red-winged blackbird (*Agelaius phoeniceus*).

TABLE 17. NUMBER OF WATERFOWL PAIRS USING STUDY PONDS, 1971 AND 1972.

Pond[1]	Mallard	Pintail	Gadwall	American Widgeon	Shoveler	Blue-Winged Teal	Green-Winged Teal	Lesser Scaup	Redhead	Canvasback	Ruddy Duck	Canada Goose	Undetermined Duck	Total
Grassland unit														
7G1														
1971	2	3	0	1	0	2	0	1	0	0	0	1	0	10
1972	2	1	3	6	0	4	0	1	0	0	0	1	0	18
Avg	2	2	2	4	0	3	0	1	0	0	0	1	0	14
7G2														
1971	2	1	2	1	1	2	2	1	0	0	0	1	0	13
1972	1	1	3	7	0	0	1	2	0	0	0	1	0	16
Avg	2	1	2	4	0	1	2	2	0	0	0	1	0	14
8G1														
1971	1	3	1	3	2	2	0	1	0	0	0	0	0	13
1972	3	6	2	7	1	2	0	0	0	0	0	2	0	23
Avg	2	4	2	5	2	2	0	0	0	0	0	1	0	18
8G2														
1971	0	1	0	0	0	0	1	0	0	0	0	0	0	2
1972	1	1	0	1	1	0	1	0	0	0	0	0	0	5
Avg	0	1	0	0	0	0	1	0	0	0	0	0	0	4
8G3														
1971	0	0	1	1	2	2	0	0	0	0	0	0	0	6
1972	0	2	0	1	0	0	0	0	0	0	0	0	0	3
Avg	0	1	0	1	1	1	0	0	0	0	0	0	0	4
9G1														
1971	3	4	3	1	1	2	0	0	0	0	0	2	0	16
1972	10	2	1	6	2	2	1	2	1	0	0	1	0	28
Avg	6	3	2	4	2	2	0	1	0	0	0	2	0	22
18G1														
1971	1	1	1	1	1	1	0	1	0	0	0	0	0	7
1972	1	2	1	2	1	1	0	0	0	0	0	1	0	9
Avg	1	2	1	2	1	1	0	0	0	0	0	0	0	8
18G2														
1971	1	0	0	0	1	0	0	0	0	0	0	0	0	2
1972	1	1	0	1	1	1	0	0	0	0	0	0	0	5
Avg	1	0	0	0	1	0	0	0	0	0	0	0	0	4

TABLE 17. (CONTINUED)

Pond	Mallard	Pintail	Gadwall	American Widgeon	Shoveler	Blue-Winged Teal	Green-Winged Teal	Lesser Scaup	Redhead	Canvasback	Ruddy Duck	Canada Goose	Undetermined Duck	Total
Grassland unit (continued)														
18G3														
1971	7	45	19	9	10	17	3	1	1	0	2	2	0	116
1972	1	3	2	3	0	2	0	1	0	0	0	3	0	15
Avg	4	24	10	6	5	10	2	1	0	0	1	2	0	66
19G1														
1971	11	12	1	7	2	2	1	0	0	0	0	0	0	36
1972	1	6	0	1	1	2	0	0	0	0	0	0	0	11
Avg	6	9	0	4	2	2	0	0	0	0	0	0	0	24
19G2														
1971	4	7	1	2	3	3	0	1	0	0	0	0	0	21
1972	1	12	0	3	1	3	0	1	0	0	0	1	0	22
Avg	2	10	0	2	2	3	0	1	0	0	0	0	0	22
20G1														
1971	1	1	0	0	0	1	0	0	0	0	0	0	0	3
1972	0	1	1	0	1	0	0	0	0	0	0	0	0	3
Avg	0	1	0	0	0	0	0	0	0	0	0	0	0	3
20GA														
1971	4	3	1	2	2	2	0	0	0	0	0	1	0	15
1972	2	1	0	1	2	0	4	0	0	0	0	0	1	11
Avg	3	2	0	2	2	1	2	0	0	0	0	0	0	13
20GB														
1971	17	25	4	9	2	5	2	0	0	0	0	3	0	67
1972	2	59	0	4	2	5	0	0	0	0	0	0	0	72
Avg	10	42	2	6	2	5	1	0	0	0	0	2	0	70
28G1														
1971	1	5	0	1	1	3	1	0	0	0	0	0	0	12
1972	1	2	0	0	0	0	0	0	0	0	0	0	0	3
Avg	1	4	0	0	0	2	0	0	0	0	0	0	0	8
28G2														
1971	1	1	1	1	1	3	0	1	0	0	0	0	0	9
1972	1	1	0	0	1	0	0	0	0	0	0	1	0	4
Avg	1	1	0	0	1	2	0	0	0	0	0	0	0	6

TABLE 17. (CONTINUED)

Pond	Mallard	Pintail	Gadwall	American Widgeon	Shoveler	Blue-Winged Teal	Green-Winged Teal	Lesser Scaup	Redhead	Canvasback	Ruddy Duck	Canada Goose	Undetermined Duck	Total
Grassland unit (continued)														
28G3														
1971	1	2	0	0	0	0	0	0	0	0	0	0	0	3
1972	2	1	0	1	0	0	0	0	0	0	0	0	0	4
Avg	2	2	0	0	0	0	0	0	0	0	0	0	0	4
28GB														
1971	6	7	0	1	1	3	0	0	0	0	0	0	0	18
1972	0	1	0	0	0	0	0	0	0	0	0	0	0	1
Avg	3	4	0	0	0	2	0	0	0	0	0	0	0	10
28GC														
1971	1	5	0	5	1	4	2	0	0	0	0	0	0	18
1972	6	8	0	3	1	0	0	0	0	0	0	0	0	18
Avg	4	6	0	4	1	2	1	0	0	0	0	0	0	18
28GD														
1971	0	0	0	1	2	3	0	0	0	0	0	0	0	6
1972	1	3	0	1	1	0	0	0	0	0	0	0	0	6
Avg	0	2	0	1	2	2	0	0	0	0	0	0	0	6
29G1														
1971	4	2	1	6	2	5	0	4	2	0	0	2	0	28
1972	1	2	0	3	1	2	0	5	2	0	0	1	0	17
Avg	2	2	0	4	2	4	0	4	2	0	0	2	0	22
29G2														
1971	2	2	2	2	3	10	3	0	1	0	0	1	0	26
1972	2	2	0	0	1	1	0	0	0	0	0	0	0	6
Avg	2	2	1	1	2	6	2	0	0	0	0	0	0	16
29GA														
1972	0	1	0	0	0	0	0	0	0	0	0	0	0	1
29GB														
1971	1	1	0	2	2	4	0	0	0	0	0	0	0	10
30G1														
1971	0	1	0	2	1	2	0	1	0	0	0	0	0	7
1972	3	1	0	1	2	1	0	0	0	0	0	1	0	9
Avg	2	1	0	2	2	2	0	0	0	0	0	0	0	8

TABLE 17. (CONTINUED)

Pond	Mallard	Pintail	Gadwall	American Widgeon	Shoveler	Blue-Winged Teal	Green-Winged Teal	Lesser Scaup	Redhead	Canvasback	Ruddy Duck	Canada Goose	Undetermined Duck	Total
Total, grassland unit														
1971	71	132	38	58	41	78	15	12	4	0	2	13	0	464
1972	43	120	13	52	20	26	7	12	3	0	0	13	1	310
Avg	57	126	26	55	30	52	11	12	4	0	1	13	0	387
Grassland fenced ponds														
G4														
1971	2	2	3	7	1	6	1	4	1	0	1	1	0	29
1972	5	5	5	5	2	2	0	2	11	0	0	1	0	38
Avg	4	4	4	6	2	4	0	3	6	0	0	1	0	34
G5														
1971	3	5	2	4	2	4	5	3	1	3	1	1	0	34
1972	15	12	4	19	0	4	0	1	1	0	0	1	0	57
Avg	9	8	3	12	1	4	2	2	1	2	0	1	0	46
Sagebrush-grassland unit														
10S1														
1971	0	0	0	2	1	2	0	0	0	0	0	0	0	5
1972	0	1	1	3	1	1	0	0	1	0	0	0	0	8
Avg	0	0	0	2	1	2	0	0	0	0	0	0	0	6
10S2														
1971	8	8	5	12	3	6	0	6	0	2	1	2	1	54
1972	2	4	4	12	3	2	0	10	1	3	0	2	0	43
Avg	5	6	4	12	3	4	0	8	0	2	0	2	0	48
14S1														
1971	3	0	0	1	0	0	1	2	0	2	0	0	0	9
1972	0	0	2	3	0	0	0	2	0	2	0	1	0	10
Avg	2	0	1	2	0	0	0	2	0	2	0	0	0	10

TABLE 17. (CONTINUED)

Pond	Mallard	Pintail	Gadwall	American Widgeon	Shoveler	Blue-Winged Teal	Green-Winged Teal	Lesser Scaup	Redhead	Canvasback	Ruddy Duck	Canada Goose	Undetermined Duck	Total
Sagebrush-grassland unit (continued)														
14S2														
1971	0	0	0	0	0	1	0	0	0	0	0	0	0	1
1972	1	0	0	1	0	0	0	0	0	0	0	0	0	2
Avg	0	0	0	0	0	0	0	0	0	0	0	0	0	2
14S3														
1971	1	1	0	3	0	0	0	0	0	0	0	0	1	6
1972	2	0	0	0	0	0	0	0	0	0	0	0	0	2
Avg	2	0	0	2	0	0	0	0	0	0	0	0	0	4
14SC														
1971	4	0	0	3	0	0	0	0	0	0	0	0	0	7
1972	1	0	0	0	0	0	0	0	0	0	0	0	0	1
Avg	2	0	0	2	0	0	0	0	0	0	0	0	0	4
15S1														
1971	1	0	0	1	0	0	0	0	0	0	0	0	0	2
1972	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Avg	0	0	0	0	0	0	0	0	0	0	0	0	0	2
15S2														
1971	1	1	0	4	0	0	0	2	0	1	0	1	0	10
1972	4	1	4	17	0	5	8	0	0	0	0	0	0	39
Avg	2	1	2	10	0	2	4	1	0	0	0	0	0	24
16S1														
1971	1	0	1	1	1	0	0	0	0	0	0	0	0	4
1972	0	0	0	1	0	0	0	0	0	0	0	0	0	1
Avg	0	0	0	1	0	0	0	0	0	0	0	0	0	2
16S2														
1971	1	0	0	2	0	0	0	0	0	0	0	1	0	4
1972	3	2	0	5	0	0	0	1	0	0	0	0	0	11
Avg	2	1	0	4	0	0	0	0	0	0	0	0	0	8
22S1														
1971	1	0	1	2	0	0	0	0	0	0	0	0	0	4
1972	3	0	1	2	0	1	0	0	0	0	0	1	0	8
Avg	2	0	1	2	0	0	0	0	0	0	0	0	0	6

TABLE 17. (CONTINUED)

Pond	Mallard	Pintail	Gadwall	American Widgeon	Shoveler	Blue-Winged Teal	Green-Winged Teal	Lesser Scaup	Redhead	Canvasback	Ruddy Duck	Canada Goose	Undetermined Duck	Total
Sagebrush-grassland unit (continued)														
23S1														
1971	1	1	2	6	0	2	0	0	0	0	0	0	0	12
1972	0	2	0	7	0	1	1	2	0	0	0	0	0	13
Avg	0	2	1	6	0	2	0	1	0	0	0	0	0	12
23S2														
1971	0	1	0	2	1	3	0	0	0	0	0	1	0	8
1972	2	2	0	1	0	1	0	0	0	0	0	0	0	6
Avg	1	2	0	2	0	2	0	0	0	0	0	0	0	7
23SC														
1971	4	0	0	0	0	0	0	0	0	0	0	0	0	4
1972	4	0	0	2	0	0	0	0	0	0	0	0	0	6
Avg	4	0	0	1	0	0	0	0	0	0	0	0	0	5
26S1														
1971	1	0	1	1	0	0	0	0	0	0	0	0	0	3
1972	2	0	1	3	0	0	0	0	0	0	0	0	0	6
Avg	2	0	1	2	0	0	0	0	0	0	0	0	0	4
26S2														
1971	0	0	0	1	0	0	0	0	0	0	0	1	0	2
1972	0	0	0	1	0	0	0	0	0	0	0	0	0	1
Avg	0	0	0	1	0	0	0	0	0	0	0	0	0	2
27S1														
1971	3	1	0	1	0	2	0	0	0	0	0	0	1	8
1972	0	0	0	1	0	1	2	0	0	0	0	0	1	5
Avg	2	0	0	1	0	2	1	0	0	0	0	0	1	6
27S2														
1971	1	1	0	1	0	0	1	0	0	0	0	0	0	4
1972	1	0	1	1	0	0	0	0	0	0	0	0	0	3
Avg	1	0	0	1	0	0	0	0	0	0	0	0	0	4
Total, sagebrush-grassland unit														
1971	31	14	10	43	6	16	2	10	0	5	1	6	3	147

TABLE 17. (CONTINUED)

Pond	Mallard	Pintail	Gadwall	American Widgeon	Shoveler	Blue-Winged Teal	Green-Winged Teal	Lesser Scaup	Redhead	Canvasback	Ruddy Duck	Canada Goose	Undetermined Duck	Total
Total, sagebrush-grassland unit (continued)														
1972	25	12	14	60	4	12	11	15	2	5	0	5	1	166
Avg	28	13	12	52	5	14	6	12	1	5	0	6	2	156
Sagebrush-grassland fenced ponds														
S2														
1971	1	1	0	1	2	0	0	0	2	0	0	0	0	7
1972	0	0	0	1	1	1	0	0	1	0	0	0	0	4
Avg	0	0	0	1	2	0	0	0	2	0	0	0	0	6
S3														
1971	6	3	2	7	0	1	1	4	2	0	0	1	0	27
1972	2	2	3	6	0	1	0	5	0	0	0	1	0	20
Avg	4	2	2	6	0	1	0	4	1	0	0	1	0	24

[1]No pairs used pond 29GA in 1971; pond 29GB in 1972; nor ponds 8GA, 20GC, 28GA, 28GE, 29GC, 29GD, and 10S3 in either year.

TABLE 18. WATERFOWL NESTS FOUND IN EACH VEGETATIONAL TYPE, 1971 AND 1972.

Species	Minimum number of eggs	Distance to nearest water (yards)	Fate of nest
Grassland			
Mallard	10	270	---
Mallard[1]	--	170	Depredated
Pintail	11	500	Hatched
Pintail	11	200	Hatched
Pintail	7	430	Hatched
Pintail	7	330	Hatched
Pintail	7	330	Depredated
Pintail	7	270	Hatched
Pintail	7	170	Depredated
Pintail	6	230	Hatched
Pintail	6	220	Depredated
Gadwall	8	430	Depredated
American Widgeon	9	330	Depredated
American Widgeon	7	330	Hatched
American Widgeon	6	120	---
Shoveler	10	530	Hatched
Shoveler	10	450	Hatched
Shoveler	10	60	Hatched
Blue-Winged Teal	13	60	Depredated
Avg, ducks	8.4	286	
Canada Goose	3	5	---
Canada Goose	--	8	---
Canada Goose	--	5	---
Canada Goose	--	5	---
Canada Goose	--	3	---
Canada Goose	--	3	---
Avg, geese	--	4.8	

TABLE 18. (CONTINUED)

Species	Minimum number of eggs	Distance to nearest water (yards)	Fate of nest
Sagebrush-grassland			
Pintail	6	50	Hatched
American Widgeon	8	700	Hatched
American Widgeon	7	270	Hatched
American Widgeon[1]	--	370	Hatched
Avg, ducks	7	348	
Canada Goose	--	30	---
Canada Goose	--	20	---
Canada Goose	--	2	---
Avg, geese	--	17.3	

[1] Species determination was uncertain.

TABLE 19. NUMBER OF WATERFOWL BROODS REARED ON STUDY PONDS, 1970-1972.

Pond[1]	Mallard	Pintail	Gadwall	American Widgeon	Shoveler	Blue-Winged Teal	Green-Winged Teal	Lesser Scaup	Redhead	Canvasback	Ruddy Duck	Canada Goose	Undetermined Duck	Total
Grassland unit														
7G1														
1970	2	0	1	0	1	1	0	0	0	0	0	0	0	5
1971	1	1	0	2	2	3	0	0	0	0	0	0	0	9
1972	1	2	0	0	0	1	0	0	0	0	0	0	0	4
Avg	1	1	0	1	1	2	0	0	0	0	0	0	0	6
7G2														
1970	0	0	1	2	2	4	0	1	0	0	0	0	2	12
1971	2	0	1	3	0	2	0	0	0	0	0	1	0	9
1972	1	1	0	2	0	0	0	0	0	0	0	0	0	4
Avg	1	0	1	2	1	2	0	0	0	0	0	0	1	8
8G1														
1970	0	1	0	0	2	4	0	0	0	0	0	0	0	7
1971	0	2	0	0	0	2	0	0	0	0	0	0	0	4
1972	1	1	0	0	1	0	0	0	0	0	0	0	0	3
Avg	0	1	0	0	1	2	0	0	0	0	0	0	0	5
8G2														
1970	0	0	0	0	1	1	0	0	0	0	0	0	0	2
1971	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Avg	0	0	0	0	0	0	0	0	0	0	0	0	0	1
8G3														
1971	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1972	0	1	0	0	1	0	0	0	0	0	0	0	0	2
Avg	0	0	0	0	0	0	0	0	0	0	0	0	0	1
9G1														
1970	0	0	1	1	1	0	0	0	0	0	0	0	0	3
1971	0	0	0	0	0	2	0	0	0	0	0	0	1	3
1972	0	0	0	2	1	0	0	0	0	0	0	0	0	3
Avg	0	0	0	1	1	1	0	0	0	0	0	0	0	3
18G1														
1970	1	0	0	0	0	0	0	0	0	0	0	0	1	2
1971	1	1	0	0	1	1	0	0	0	0	0	0	0	4

TABLE 19. (CONTINUED)

Pond	Mallard	Pintail	Gadwall	American Widgeon	Shoveler	Blue-Winged Teal	Green-Winged Teal	Lesser Scaup	Redhead	Canvasback	Ruddy Duck	Canada Goose	Undetermined Duck	Total
Grassland unit (continued)														
18G1 (continued)														
1972	2	0	1	0	0	2	0	0	0	0	0	0	0	5
Avg	1	0	0	0	0	1	0	0	0	0	0	0	0	4
18G3														
1970	1	0	1	1	8	4	0	0	0	0	0	1	2	18
1971	2	6	1	3	2	11	0	0	0	0	0	2	0	27
1972	2	1	0	1	1	1	0	0	0	0	0	1	2	9
Avg	2	2	1	2	4	5	0	0	0	0	0	1	1	18
19G1														
1970	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	2	0	0	0	0	0	0	0	0	0	0	1	3
1972	0	1	0	0	0	0	0	0	0	0	0	0	0	1
Avg	0	1	0	0	0	0	0	0	0	0	0	0	0	1
19G2														
1970	0	1	0	0	1	1	0	0	0	0	0	0	0	3
1971	0	0	0	0	0	2	0	0	0	0	0	0	0	2
1972	0	1	0	0	0	0	0	0	0	0	0	0	0	1
Avg	0	1	0	0	0	1	0	0	0	0	0	0	0	2
20GA														
1971	0	2	0	0	0	0	0	0	0	0	0	0	0	2
1972	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Avg	0	1	0	0	0	0	0	0	0	0	0	0	0	1
28G2														
1970	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	1	0	0	0	0	0	0	0	1
1972	2	2	0	0	0	0	0	0	0	0	0	1	1	6
Avg	1	1	0	0	0	0	0	0	0	0	0	0	0	2
28G3														
1970	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	1	0	0	0	0	0	0	0	1
Avg	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE 19. (CONTINUED)

Pond	Mallard	Pintail	Gadwall	American Widgeon	Shoveler	Blue-Winged Teal	Green-Winged Teal	Lesser Scaup	Redhead	Canvasback	Ruddy Duck	Canada Goose	Undetermined Duck	Total
Grassland unit (continued)														
28GB														
1971	0	1	0	0	0	0	0	0	0	0	0	0	0	1
1972	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Avg	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29G1														
1970	1	0	4	2	0	2	0	1	0	0	0	2	2	14
1971	0	2	4	5	2	2	0	1	0	0	0	3	5	24
1972	0	0	2	14	1	2	0	1	0	0	0	0	0	20
Avg	0	1	3	7	1	2	0	1	0	0	0	2	2	19
29G2														
1970	1	1	0	0	0	1	0	0	0	0	0	3	0	6
1971	1	1	0	0	0	3	0	0	0	0	0	2	1	8
1972	0	0	0	2	1	0	0	0	0	0	0	0	0	3
Avg	1	1	0	1	0	1	0	0	0	0	0	2	0	6
30G1														
1970	0	1	1	3	4	6	0	0	0	0	0	0	1	16
1971	1	0	0	1	1	0	0	0	0	0	0	0	1	4
1972	0	2	1	0	0	0	0	0	0	0	0	0	0	3
Avg	0	1	1	1	2	2	0	0	0	0	0	0	1	8
Total, grassland unit														
1971	8	18	6	14	8	29	0	1	0	0	0	8	9	101
1972	9	12	4	21	6	7	0	1	0	0	0	2	3	65
Avg	8	15	5	18	7	18	0	1	0	0	0	5	6	83
Grassland fenced ponds														
G4														
1971	4	3	0	2	8	5	0	1	4	1	1	0	3	32
1972	2	3	7	10	3	3	0	1	0	0	0	2	1	32
Avg	3	3	4	6	6	4	0	1	2	0	0	1	2	32

TABLE 19. (CONTINUED)

Pond	Mallard	Pintail	Gadwall	American Widgeon	Shoveler	Blue-Winged Teal	Green-Winged Teal	Lesser Scaup	Redhead	Canvasback	Ruddy Duck	Canada Goose	Undetermined Duck	Total
Grassland fenced ponds (continued)														
G5														
1970	1	0	1	2	0	0	0	0	0	0	0	0	0	4
1971	5	1	0	5	2	0	0	0	0	1	0	2	7	23
1972	1	0	3	3	1	5	0	1	0	0	0	0	1	15
Avg	2	0	1	3	1	2	0	0	0	0	0	1	3	14
Sagebrush-grassland unit														
10S1														
1970	1	0	0	6	0	1	0	0	0	0	0	0	0	8
1971	1	1	0	7	1	4	0	0	0	0	0	1	0	15
1972	0	2	6	10	0	2	0	0	0	0	0	0	1	21
Avg	1	1	2	8	0	2	0	0	0	0	0	0	0	15
10S2														
1970	3	0	5	15	1	7	0	5	0	4	0	0	0	40
1971	2	0	1	23	0	5	0	5	0	0	0	1	3	40
1972	0	0	7	23	1	7	0	5	0	0	0	2	3	48
Avg	2	0	5	20	1	6	0	5	0	1	0	1	2	43
14S1														
1970	0	0	0	0	0	0	0	0	0	0	0	0	2	2
1971	0	0	0	0	0	0	0	0	0	0	0	0	4	4
1972	2	0	0	4	0	1	0	0	0	0	0	0	4	11
Avg	1	0	0	1	0	0	0	0	0	0	0	0	3	6
14S2														
1970	0	0	0	0	0	0	0	0	0	0	0	0	1	1
1971	1	0	0	0	0	0	0	0	0	0	0	0	0	1
1972	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Avg	0	0	0	0	0	0	0	0	0	0	0	0	0	1
14S3														
1970	2	0	0	1	0	0	0	0	0	0	0	0	0	3
1971	1	0	0	0	0	0	0	0	0	0	0	0	1	2

TABLE 19. (CONTINUED)

Pond	Mallard	Pintail	Gadwall	American Widgeon	Shoveler	Blue-Winged Teal	Green-Winged Teal	Lesser Scaup	Redhead	Canvasback	Ruddy Duck	Canada Goose	Undetermined Duck	Total
Sagebrush-grassland unit (continued)														
14S3 (continued)														
1972	0	0	1	0	0	0	1	0	0	0	0	0	1	3
Avg	1	0	0	0	0	0	0	0	0	0	0	0	1	3
15S2														
1970	1	0	0	2	0	0	0	0	0	0	0	0	1	4
1971	0	0	1	5	0	0	0	1	0	0	0	1	0	8
1972	2	0	0	4	0	1	0	0	0	0	0	0	0	7
Avg	1	0	0	4	0	0	0	0	0	0	0	0	0	6
16S1														
1970	0	0	1	0	0	1	0	0	0	0	0	0	0	2
1971	1	0	0	0	0	0	0	0	0	0	0	0	0	1
1972	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Avg	0	0	0	0	0	0	0	0	0	0	0	0	0	1
16S2														
1970	0	0	0	0	0	1	0	0	0	0	0	0	0	1
1971	0	0	0	1	0	0	0	2	0	0	0	0	1	4
1972	0	0	0	1	0	1	0	0	0	0	0	0	0	2
Avg	0	0	0	1	0	1	0	1	0	0	0	0	0	2
23S1														
1970	1	0	0	1	0	1	0	0	0	0	0	0	0	3
1971	2	1	2	3	0	0	0	0	0	0	0	0	0	8
1972	0	0	0	3	0	1	0	1	0	0	0	0	0	5
Avg	1	0	1	2	0	1	0	0	0	0	0	0	0	5
23S2														
1970	0	0	0	0	0	0	0	0	0	0	0	0	1	1
1971	2	1	0	0	0	1	0	0	0	0	0	0	0	4
1972	0	0	2	0	0	2	0	0	0	0	0	0	0	4
Avg	1	0	1	0	0	1	0	0	0	0	0	0	0	3
26S1														
1970	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	1	0	0	0	0	0	0	0	0	0	1
1972	0	1	0	0	0	0	0	0	0	0	0	0	0	1
Avg	0	0	0	0	0	0	0	0	0	0	0	0	0	1

TABLE 19. (CONTINUED)

Pond	Mallard	Pintail	Gadwall	American Widgeon	Shoveler	Blue-Winged Teal	Green-Winged Teal	Lesser Scaup	Redhead	Canvasback	Ruddy Duck	Canada Goose	Undetermined Duck	Total
Sagebrush-grassland unit (continued)														
26S2														
1970	1	0	0	0	0	2	0	0	0	0	0	0	1	4
1971	0	1	0	0	0	1	0	0	0	0	0	0	0	2
1972	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Avg	0	0	0	0	0	1	0	0	0	0	0	0	0	2
27S1														
1970	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1971	1	0	0	1	0	0	0	0	0	0	0	0	0	2
1972	0	0	0	1	0	0	0	0	0	0	0	0	0	1
Avg	0	0	0	1	0	0	0	0	0	0	0	0	0	1
27S2														
1970	0	0	0	0	0	2	0	0	0	0	0	0	0	2
1971	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Avg	0	0	0	0	0	1	0	0	0	0	0	0	0	1
Total, sagebrush-grassland unit														
1970	9	0	6	25	1	15	0	5	0	4	0	0	6	71
1971	11	4	4	41	1	11	0	8	0	0	0	3	9	92
1972	4	3	16	46	1	15	1	6	0	0	0	2	9	103
Avg	8	2	9	37	1	14	0	6	0	1	0	2	8	89
Sagebrush-grassland fenced ponds														
S2														
1970	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	1	0	1	0	0	0	0	0	0	0	0	0	2
1972	0	0	0	0	0	0	0	0	0	1	0	0	0	1
Avg	0	0	0	0	0	0	0	0	0	0	0	0	0	1

TABLE 19. (CONTINUED)

Pond	Mallard	Pintail	Gadwall	American Widgeon	Shoveler	Blue-Winged Teal	Green-Winged Teal	Lesser Scaup	Redhead	Canvasback	Ruddy Duck	Canada Goose	Undetermined Duck	Total
Sagebrush-grassland fenced ponds (continued)														
S3														
1970	4	0	0	3	1	1	0	2	0	0	0	0	0	11
1971	2	1	5	8	0	0	0	1	0	0	0	0	0	17
1972	0	0	3	1	0	0	0	0	0	0	0	1	0	5
Avg	2	0	3	4	0	0	0	1	0	0	0	0	0	11

[1]No broods were reared on ponds 8GA, 20GC, 28GA, 28GE, 29GA, 29GB, 29GC, and 29GD in 1971 and 1972; nor on ponds 18G2, 20G1, 20GB, 28G1, 28GC, 28GD, 10S3, 14SC, 15S1, 22S1, and 23SC in 1970, 1971, and 1972.

TABLE 20. AVERAGE SIZE OF WATERFOWL BROODS OBSERVED ON THE STUDY PONDS.

Species	Plumage class[1] I G[2]		I S[3]		I G+S		II G		II S		II G+S		III G		III S		III G+S	
Mallard	5.2	(14)[4]	5.5	(15)	5.4	(29)	4.8	(12)	3.7	(13)	4.2	(25)	5.6	(16)	3.8	(8)	5.0	(24)
Pintail	5.1	(19)	5.8	(4)	5.2	(23)	2.9	(12)	2.3	(3)	2.8	(15)	3.1	(18)	3.2	(4)	3.1	(22)
Gadwall	6.9	(13)	6.2	(16)	6.5	(29)	4.4	(17)	4.9	(17)	4.7	(34)	7.0	(2)	6.0	(6)	6.2	(8)
American Widgeon	4.8	(37)	5.5	(63)	5.2	(100)	4.3	(28)	4.2	(42)	4.3	(70)	4.4	(5)	4.4	(7)	4.4	(12)
Shoveler	6.8	(20)	4.0	(1)	6.7	(21)	4.0	(22)	1.0	(1)	3.9	(23)	7.0	(8)	4.5	(2)	6.5	(10)
Blue-Winged Teal	6.0	(20)	5.0	(12)	5.6	(32)	5.9	(34)	4.3	(30)	5.1	(64)	6.0	(22)	1.7	(3)	5.5	(25)
Green-Winged Teal		(0)		(0)		(0)		(0)		(0)		(0)		(0)	5.0	(1)	5.0	(1)
Lesser Scaup	5.1	(7)	6.9	(16)	6.4	(23)	10.5	(2)	5.9	(9)	6.7	(11)		(0)	8.5	(2)	8.5	(2)
Redhead	5.8	(4)		(0)	5.8	(4)		(0)		(0)		(0)		(0)		(0)		(0)
Canvasback	5.0	(1)	4.5	(2)	4.7	(3)	5.0	(2)	4.8	(5)	4.9	(7)		(0)	7.0	(1)	7.0	(1)
Ruddy Duck	6.0	(1)		(0)	6.0	(1)		(0)		(0)		(0)		(0)		(0)		(0)
Undetermined Duck	1.8	(18)	1.8	(15)	1.8	(33)	2.0	(9)	1.2	(5)	1.7	(14)		(0)		(0)		(0)
All Ducks	5.2	(154)	5.3	(144)	5.2	(298)	4.5	(138)	4.2	(125)	4.4	(263)	5.2	(71)	4.5	(34)	5.0	(105)
Canada Goose	4.7	(10)	5.0	(3)	4.8	(13)	5.7	(3)		(0)	5.7	(3)	3.9	(9)	6.0	(1)	4.1	(10)

[1] From Gollop and Marshall (1954) and Yocom and Harris (1965).
[2] Grassland vegetational type.
[3] Sagebrush-grassland vegetational type.
[4] Sample size.

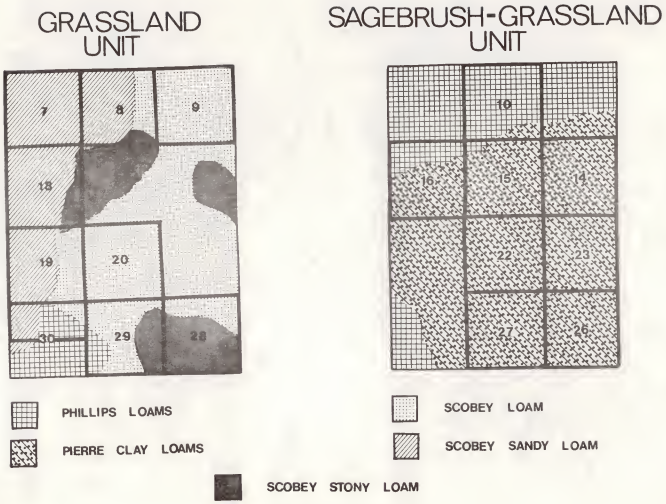

Figure 18. Soil types of the two study units.

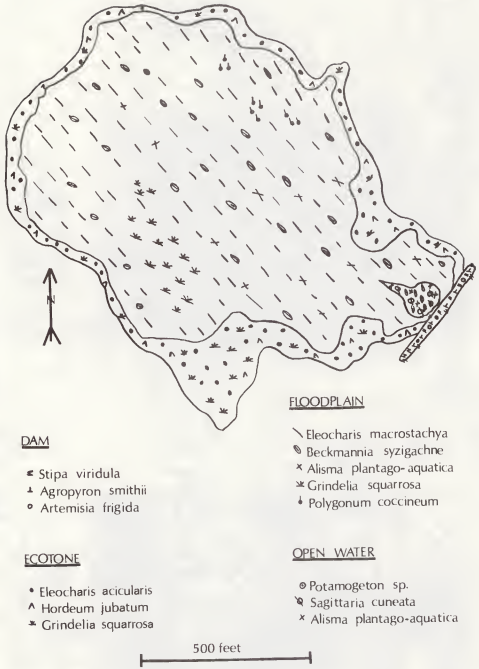

Figure 19. Cover map of pond 19G1, a grassland retention reservoir having an extensive floodplain.

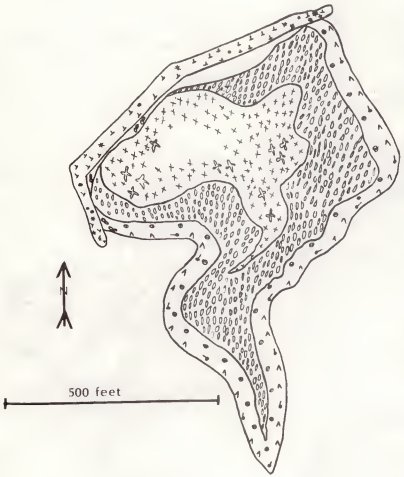

Figure 20. Cover map of pond 9G1, a retention reservoir in the grassland unit.

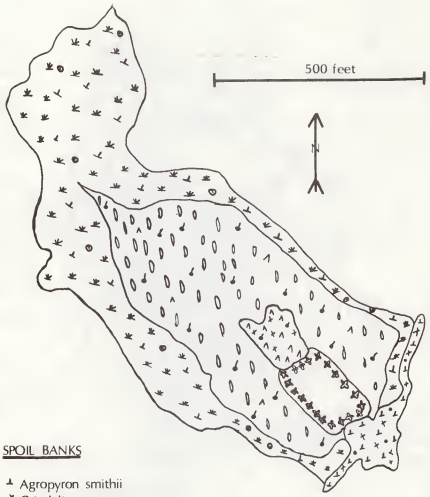

Figure 21. Cover map of pond 29G2, a grassland dugout in a natural pothole.

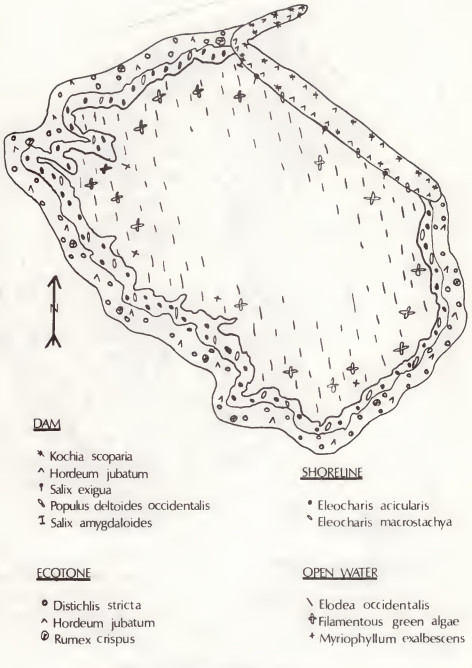

Figure 22. Cover map of pond 15S2, a retention reservoir in the sagebrush-grassland unit.

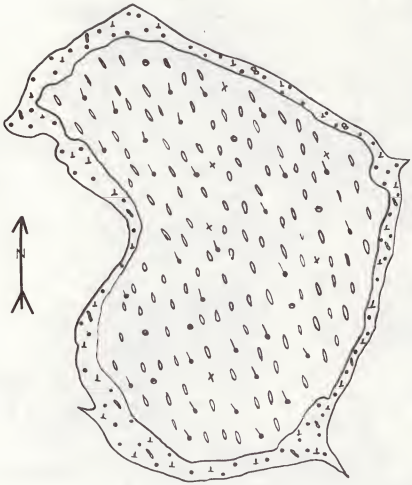

Figure 23. Cover map of pond 20GA, a natural pothole in the grassland unit.

LITERATURE CITED

American Ornithologists' Union. 1957. Check-list of North American birds. 5th ed. Amer. Ornithologists' Union, Ithaca, New York. 691 p.

Berg, P. F. 1956. A study of waterfowl broods in eastern Montana with special reference to movements and the relationship of reservoir fencing to production. J. Wildl. Manage. 20(3):253-262.

Booth, W. E. 1950. Flora of Montana. Part I. The Res. Found. at Montana State Coll., Bozeman. 232 p.

_____, and J. C. Wright. 1959. Flora of Montana. Part II. Dep. of Bot. and Microbiol., Montana State Univ., Bozeman. 305 p.

Bue, I. G., L. Blankenship, and W. H. Marshall. 1952. The relationship of grazing practices to waterfowl breeding populations and production on stock ponds in western South Dakota. Trans. N. Amer. Wildl. Conf. 17:396-414.

_____, H. G. Uhlig, and J. D. Smith. 1964. Stock ponds and dugouts, p. 391-398. *In* J. P. Linduska [ed.] Waterfowl tomorrow. U. S. Dep. Interior, Washington, D. C.

Burwell, R. W., and L. G. Sugden. 1964. Potholes--going, going...., p. 369-380. *In* J. P. Linduska [ed.] Waterfowl tomorrow. U. S. Dep. Interior, Washington, D. C.

Cockrum, E. L. 1952. A check-list and bibliography of hybrid birds in North America north of Mexico. The Wilson Bull. 64(3):140-159.

Daubenmire, R. F. 1959a. A canopy-coverage method of vegetational analysis. Northwest Sci. 33(1):43-64.

_____. 1959b. Plants and environment. 2nd ed. John Wiley & Sons, Inc., New York. 422 p.

Edminster, F. C. 1964. Farm ponds and waterfowl, p. 399-407. *In* J. P. Linduska [ed.] Waterfowl tomorrow. U. S. Dep. Interior, Washington, D. C.

Eisenlohr, W. S., Jr. 1969. Hydrology of small water areas in the prairie pothole region, p. 35-39. *In* Saskatoon wetlands seminar. Canadian Wildl. Serv. Rep. Series No. 6. Dep. of Indian Affairs and Northern Development, Ottawa.

_____, and C. E. Sloan. 1968. Generalized hydrology of prairie potholes on the Coteau du Missouri, North Dakota. Geol. Surv. Circular 558. Geol. Surv., U. S. Dep. of Interior, Washington, D.C. 12 p.

Ellig, L. J. 1955. Waterfowl relationships to Greenfields Lake, Teton County, Montana. Montana Fish & Game Comm. Tech. Bull. No. 1. 35 p.

Evans, C. D., A. S. Hawkins, and W. H. Marshall. 1952. Movements of waterfowl broods in Manitoba. U. S. Fish and Wildl. Service, Special Sci. Rep.--Wildl., No. 16. 47 p.

Gieseker, L. F. 1926. Soils of Phillips County. Montana Agr. Expt. Sta. Bull. No. 199. 61 p.

Gjersing, F. M. 1971. A study of waterfowl production on two rest rotation grazing units in northcentral Montana. Unpub. M. S. Thesis. Montana State Univ., Bozeman. 42 p.

Gollop, J. B., and W. H. Marshall. 1954. A guide for aging duck broods in the field. Mississippi Flyway Council Tech. Sect. 14 p. Mimeo.

Hammond, M. C. 1959. Waterfowl breeding population census techniques. Branch of Wildlife Refuges, Bur. of Sport Fisheries and Wildl. 19 p. Mimeo.

Higgins, K. F., L. M. Kirsch, and I. J. Ball, Jr. 1969. A cable-chain device for locating duck nests. J. Wildl. Manage. 33(4):1009-1011.

Hochbaum, H. A. 1959. The canvasback on a prairie marsh. 2nd ed. The Wildl. Manage. Institute, Washington, D. C. 207 p.

Hook, D. L. 1973. Production and habitat use by Canada geese at Freezout Lake, Montana. Unpub. M. S. Thesis. Montana State Univ., Bozeman. 53 p.

Jones, J. D. 1970. Stock ponds becoming Montana duck factories. Mont. Outdoors. 5(2):1-3.

Kalmbach, E. R. 1939. Nesting success: its significance in waterfowl reproduction. Trans. N. Amer. Wildl. Conf. 4:591-604.

Keith, L. B. 1961. A study of waterfowl ecology on small impoundments in southeastern Alberta. Wildl. Monogr. No. 6. 88 p.

Kortright, F. H. 1953. The ducks, geese and swans of North America. Wildl. Manage. Institute, Washington, D. C. 476 p.

Labisky, R. F. 1957. Relation of hay harvesting to duck nesting under a refuge-permittee system. J. Wildl. Manage. 21(2):194-200.

Martin, A. C., H. S. Zim, and A. L. Nelson. 1951. American wildlife and plants. McGraw-Hill Book Co., Inc., New York. 500 p.

McCarthy, J. J. 1973. Response of nesting Canada geese *(Branta canadensis)* to islands in stockdams in northcentral Montana. Unpub. M. S. Thesis. Montana State Univ., Bozeman. 36 p.

McKinney, F. 1965. Spacing and chasing in breeding ducks. Wildfowl Trust Annual Rep. 16:92-106.

Miller, A. W., and B. D. Collins. 1954. A nesting study of ducks and coots on Tule Lake and Lower Klamath National Wildlife Refuges. Cal. Fish & Game. 40(1):17-37.

Munro, D. A. 1963. Ducks and the Great Plains wetlands. Canadian Audubon Magazine. Sept.-Oct. 1963. Reprint. 8 p.

Odum, E. P. 1971. Fundamentals of ecology. 3rd ed. W. B. Saunders Co., Philadelphia. 574 p.

Ostle, B. 1963. Statistics in research. 2nd ed. Iowa State Univ. Press, Ames. 585 p.

Rearden, J. D. 1951. Identification of waterfowl nest predators. J. Wildl. Manage. 15(4):386-395.

Robbins, C. S., B. Bruun, and H. S. Zim. 1966. Birds of North America. Golden Press, Inc., New York. 340 p.

Rogers, J. P. 1964. Effect of drought on reproduction of the lesser scaup. J. Wildl. Manage. 28(2):213-222.

Shearer, L. A. 1960. Use of dugouts by breeding ducks. J. Wildl. Manage. 24(2):213-215.

Smith, A. G. 1971. Ecological factors affecting waterfowl production in the Alberta parklands. Resource Pub. 98 of the Bur. of Sport Fisheries and Wildl., Washington, D. C. 49 p.

_____, J. H. Stoudt, and J. B. Gollop. 1964. Prairie potholes and marshes, p. 39-50. *In* J. P. Linduska [ed.] Waterfowl tomorrow. U. S. Dep. Interior, Washington, D. C.

Smith, R. H. 1953. A study of waterfowl production on artificial reservoirs in eastern Montana. J. Wildl. Manage. 17(3):276-291.

Sowls, L. K. 1955. Prairie ducks: a study of their behavior, ecology and management. The Stackpole Co., Harrisburg, Pa., and Wildl. Manage. Institute, Washington, D. C. 193 p.

Steel, R. G. D., and J. H. Torrie. 1960. Principles and procedures of statistics. McGraw-Hill Book Co., Inc., New York. 481 p.

Stewart, R. E., and H. A. Kantrud. 1971. Classification of natural ponds and lakes in the glaciated prairie region. Resource Pub. 92. Bur. of Sport Fisheries and Wildl., Washington, D. C. 57 p.

Stoddart, L. A., and A. D. Smith. 1955. Range management. 2nd ed. McGraw-Hill Book Co., Inc., New York. 433 p.

Stoudt, J. H. 1971. Ecological factors affecting waterfowl production in the Saskatchewan parklands. Resource Pub. 99 of the Bur. of Sport Fisheries and Wildl., Washington, D. C. 58 p.

Studholme, A. T., and T. Sterling. 1964. Dredges and ditches, p. 359-368. *In* J. P. Linduska [ed.] Waterfowl tomorrow. U. S. Dep. Interior, Washington, D. C.

U. S. Department of Commerce. 1960-1972. Climatological data. U. S. Dep. of Commerce, Washington, D. C. 63(1)-75(13).

Welch, P. S. 1948. Limnological methods. McGraw-Hill Book Co., Inc., New York. 381 p.

Weller, M. W. 1956. A simple field candler for waterfowl eggs. J. Wildl. Manage. 20(2):111-113.

Yocom, C. F., and S. W. Harris. 1965. Plumage descriptions and age data for Canada goose goslings. J. Wildl. Manage. 29(4):874-877.